US Army Corps
of Engineers
Wilmington District

FINAL

Environmental Impact Statement

Long-Term Maintenance of Wilmington Harbor North Carolina

October 1989

FINAL
ENVIRONMENTAL IMPACT STATEMENT
for
THE LONG-TERM MAINTENANCE OF WILMINGTON HARBOR
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA

Abstract: Wilmington Harbor is a Federal navigation project maintained by the Wilmington District Corps of Engineers since 1829. The depth and width of the navigation channel have been increased several times and now can handle ships with drafts up to 38 feet. Approximately 2.3 million cubic yards of sediment are dredged from the navigation project annually in order to maintain authorized dimensions. The purpose of this environmental impact statement (EIS) is to indicate the plan for dredging and disposal of this sediment for the next 50 years. Dredging methods proposed include hopper, hydraulic pipeline and bucket dredges with disposal in a designated ocean dredged material disposal site (ODMDS) or in diked upland sites. All dredging and disposal methods are technically and economically feasible and environmentally acceptable. Several alternatives were considered but they were not acceptable for technical, economic or environmental reasons. **The only controversy concerns the disposal of dredged material in a previously used disposal site (site 18) in the upstream segment of the harbor.**

SEND YOUR COMMENTS TO THE DISTRICT ENGINEER BY

January 5, 1990

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NOTE: CHANGES BETWEEN THE DRAFT AND FINAL EIS ARE INDICATED IN BOLD TYPE.

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FINAL
ENVIRONMENTAL IMPACT STATEMENT

for
The Long-Term Maintenance of Wilmington Harbor
New Hanover and Brunswick Counties, North Carolina

October 1989

1.0 SUMMARY

1.1 Major Conclusions and Findings. A 50 year maintenance plan has been developed for Wilmington Harbor for dredging the project to authorized dimensions and disposing the dredged material in a technically feasible and environmentally sound manner. Maintenance of Wilmington Harbor is justified based on the economic value of the harbor to the region, state and nation and lack of significant adverse impacts on the environment. The estimated full time equivalent jobs throughout North Carolina attributed to the harbor at Wilmington was 59,000 in 1982. Revenue derived from the port in 1982 included approximately $900,000,000 in total salaries and benefits and $117,000,000 in local and state taxes.

Potential adverse impacts associated with continued maintenance center around disposal of 2.3 million cubic yards of dredged material annually. This impact is minimized since all disposal areas selected for the 50 year maintenance plan have previously been used for the disposal of dredged material.

1.2 Areas of Controversy. **The only controversy concerns the disposal of dredged material in a previously used disposal site (site 18) in the upstream segment of the harbor.**

1.3 Unresolved issues. There are no unresolved issues.

1.4 Relationship of Proposed Action to Environmental Requirements. Table 1 summarizes the relationship of the proposed action to Federal, state and local requirements.

TABLE 1

Relationship of Proposed Action to Environmental Requirements

Federal Policies	Proposed Action
National Historic Preservation Act of 1966, as amended	Full Compliance
National Environmental Policy Act of 1969, as amended	Full Compliance
Clean Water Act of 1977, as amended	Full Compliance
Clean Air Act, as amended	Full Compliance
Coastal Zone Management Act of 1972, as amended	Full Compliance
Endangered Species Act of 1973, as amended	Full Compliance
Estuary Protection Act	Full Compliance
Federal Water Project Recreation Act	Full Compliance
Marine Protection, Research, and Sanctuaries Act of 1972, as amended	Full Compliance
Fish and Wildlife Coordination Act, as amended	Full Compliance
Rivers and Harbor Act	Not Applicable
Watershed Protection and Flood Prevention Act	Not Applicable
Wild and Scenic Rivers Act	Not Applicable
Land and Water Conservation Fund Act	Not Applicable
Executive Orders, Memoranda, etc.	
EO 11988, Flood Plain Management	Full Compliance
EO 11990, Protection of Wetlands	Full Compliance

Table 1 (continued)

State Policies	
Coastal Area Management Act of 1974	Full Compliance
Local Policies	
Land Use Plans, New Hanover and Brunswick Counties	Full Compliance

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2.0 PURPOSE AND NEED.

2.1 Introduction. The purpose of this environmental impact statement (EIS) is to present the proposed 50 year maintenance plan for the Wilmington Harbor project and to identify the environmental effects of the plan. This maintenance plan involves dredging the project to authorized dimensions and disposing the dredged material in a technically feasible and environmentally sound manner. An EIS for Wilmington Harbor was published in 1977 but that EIS was only valid for 10 years (US Army Engineer District, Wilmington 1977). This 10 year period was to allow sufficient time for establishment and implementation of a long-term maintenance plan, the subject of the present **final** EIS.

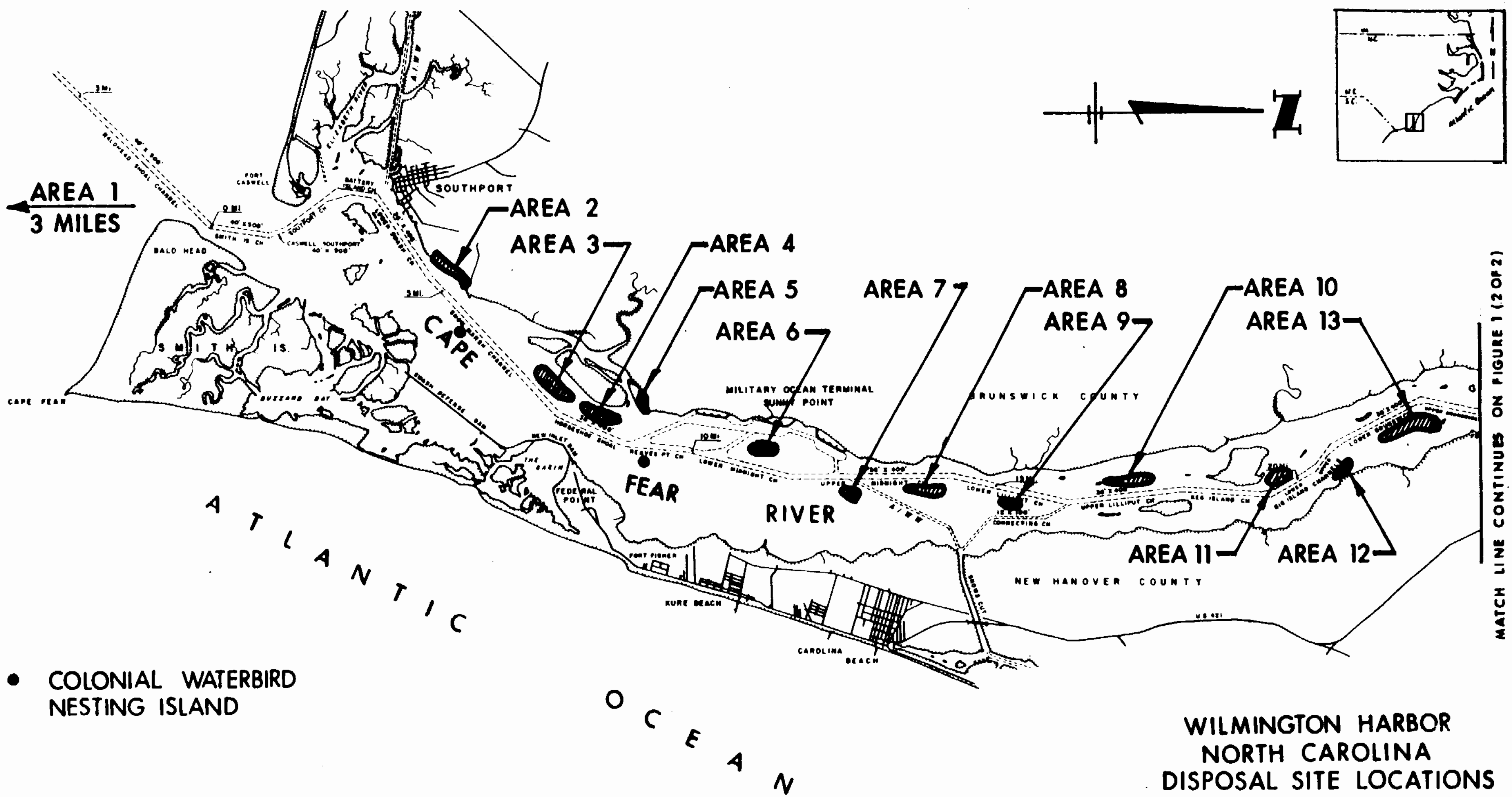
Wilmington Harbor is located along the lower Cape Fear River, in New Hanover and Brunswick Counties, North Carolina. The Wilmington Harbor project consists of a series of channels or "reaches," extending from the ocean bar at the mouth of the Cape Fear River to a point 1.67 miles above the Hilton Bridge at Wilmington, a total distance of 30.8 miles (figure 1). The project requires periodic maintenance (removal of shoals) in order to maintain an orderly, efficient and safe flow of traffic from the ocean to the NC State Ports, public and private facilities and other navigation projects.

2.2 Project History. A chronological listing of early dredging efforts in the Cape Fear River is given below:

1817 - State of North Carolina authorized the creation of a commission to investigate the navigability of the State's rivers.

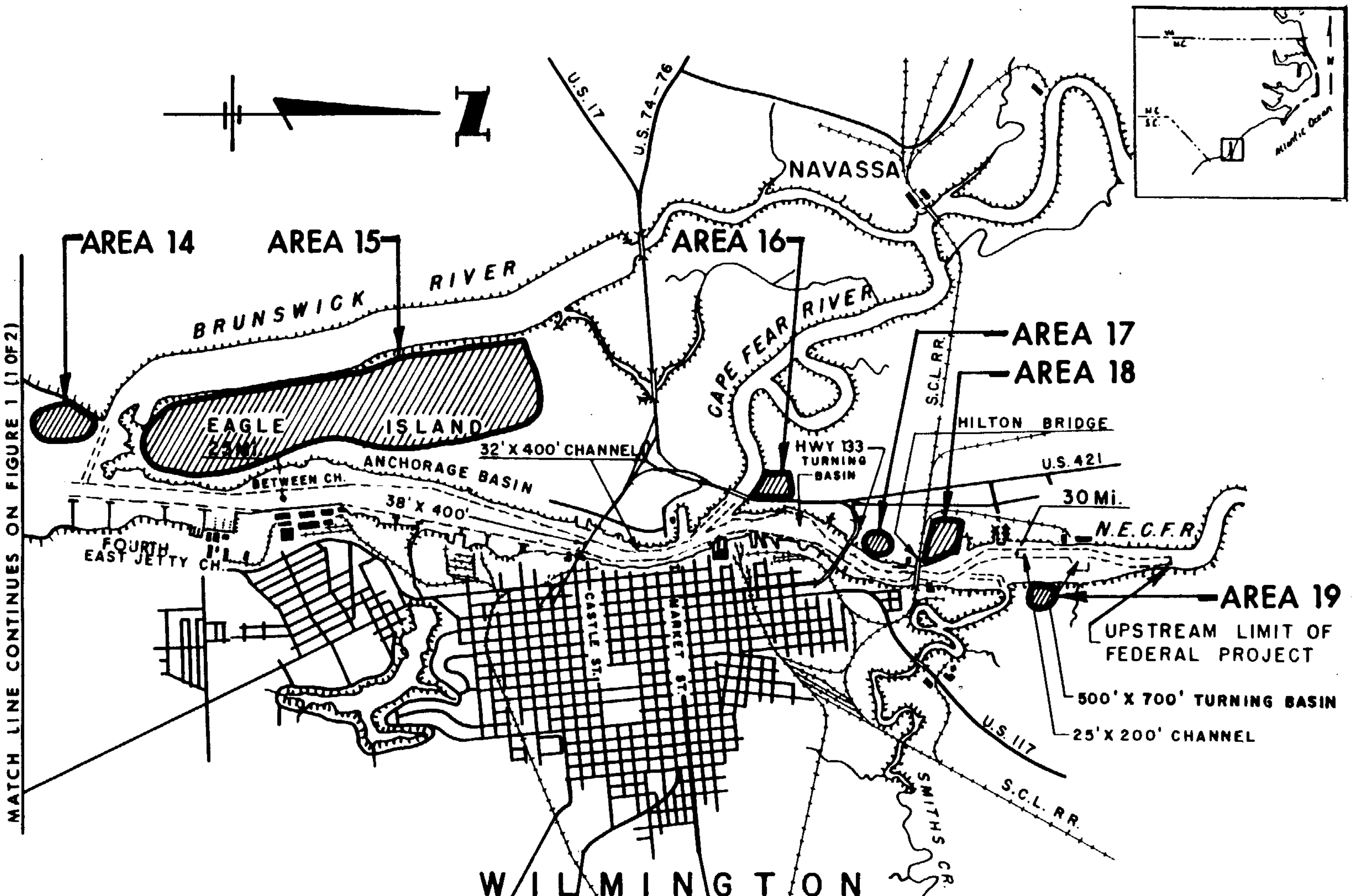
1822 - State of North Carolina implemented a program to improve the river between Wilmington and Big Island (Campbell Island) by embankments, jetties, and dredging. This resulted in a gain of depth of 2 feet.

1829 - The US Army Corps of Engineers (USACE) undertook the dredging and maintenance of the ship channel in the river for a period of 10 years. This channel extended from a point 2.7 miles above the confluence of the Cape Fear and the Northeast Rivers and extended 3 miles into the ocean, across the bar formed by Middle Ground and Baldhead shoals. The State of North Carolina authorized a charter to the Cape Fear and Deep River Navigation Company to make the upper Cape Fear and the Deep River navigable above Fayetteville, North Carolina. This was to provide economical transport for coal mined from the then active coal fields in Chatham County. Between the time of the charter and the Civil War, North Carolina contributed large sums of money to the development and maintenance of these channels. The hopes of making Chatham a major coal producing area dwindled after the Civil War when the vein was exhausted.



WILMINGTON HARBOR
NORTH CAROLINA
DISPOSAL SITE LOCATIONS

FIGURE 1 (1 of 2)



WILMINGTON HARBOR
NORTH CAROLINA
DISPOSAL SITE LOCATIONS

SCALE OF MILES

FIGURE 1 (2 of 2)

1871 - The USACE began straightening and deepening the barge channel by dredging and diverting the tidal flow from New Inlet by closing the breach between Zekes Island and Federal Point. Work began to close New Inlet by a stone dam, 5,300 feet long. The channel was dredged to a depth of 12 feet and a width of 100 feet from the entrance channel to Wilmington.

1889 - Swash defense dam, a stone structure 12,800 feet long running between Zekes Island and Smith Island, was completed.

1890 - The ship channel was dredged and maintained to a depth of 20 feet and a width of 270 feet from Wilmington to the ocean.

1912 - The Rivers and Harbors Act provided for a 26-foot-deep channel with a width at the ocean bar of 400 feet, thence 26 feet deep and 300 feet wide to Wilmington.

1930 - The river channel was deepened to 30 feet with increased width at its bends. The anchorage basin at Wilmington and turning basins opposite principal terminals were enlarged. The AIWW Snows Cut Channel was completed with a 12-foot depth and 100-foot width.

1945 - The ship channel was increased to 400 feet wide by 32 feet deep up to Wilmington and the turning basin was enlarged. A channel, 12 feet deep and 100 feet wide, was dredged between the AIWW and the river channel.

1948 - A 200 feet wide by 25 feet deep channel was dredged from the Hilton Bridge upstream for 1.25 miles. A 600 feet wide by 600 feet long turning basin was also dredged at the upstream end.

1950 - The depth over the ocean bar was increased to 35 feet and depth of the remaining reaches was increased to 34 feet up to Castle Street, in Wilmington.

1955 - MOTSU (Military Ocean Terminal at Sunny Point) was opened and entrance channels dredged.

1965 - The 200 feet wide by 25 feet deep channel above the Hilton Bridge was extended 2200 feet upstream of the turning basin and the width and length of the turning basin was increased 100 feet.

1966-1970 - The navigation channel in the river was increased to 38 feet by 400 feet up to Castle Street, in Wilmington.

1971 - Navigation channel over the ocean bar was deepened to 40 feet and maintained at a width of 500 feet.

1972 - Navigation improvements were made in river adjacent to Wilmington (above Castle Street) to a depth of 32 feet by 400 feet.

1982 - Turning basin opposite the NC State Port Terminal was widened.

2.3 Project Authorization. Current and past project authorizations for Wilmington Harbor are given in chart form below:

Date	Work Authorized	Documents
July 3, 1930	30' x 300' channel to Wilmington; anchorage basin, 2,000' long; turning basin, 600' x 1,000'	R&H Com. Doc. 39/71/2
March 2, 1945	Increase width of existing channel to 400'; increase width of turning basin to 800'; a 12' x 100' connecting channel with the Intracoastal Waterway	HD 131/76/1
March 2, 1945	Increase depth to 32'	SD 83/76/1
March 2, 1945	25' x 200' channel from Hilton Bridge to a 600' wide basin, 1-1/4 miles above	SD 170/76/3
May 17, 1950	Increase depth of bar channel to 35', river channel to 34' to Castle Street	HD 87/81/1
Oct. 23, 1962	Increase width of bar channel to 500' and 40' deep, and depth of river channel to 38' up to Castle Street	SD 114/87/2
March 10, 1964	Enlarge basin and extend channel above Hilton Bridge	Detailed Project Report, Feb. 17, 1964
July 13, 1982	Widen turning basin opposite N.C. State Ports facility	Letter Report, 8 July 1982

2.4 Public Concerns. The public concerns about the project fall into two major categories. First is that the harbor be adequately maintained over the long-term so that ship traffic can flow in and out of the harbor efficiently and safely. The second is that long-term maintenance of the harbor does not have significant adverse impacts on the environment. Both these concerns are thoroughly addressed in this EIS.

2.5 Planning Objectives. In line with the public concerns, the major planning objective was to develop a maintenance plan that would provide adequate maintenance over the 50 year planning period with minimal impacts on the environment.

3.0 Alternatives Including Proposed Action.

3.1 Existing Project.

3.1.1 Project Dimensions. The 30.8-mile-long project consists of a channel, 40 feet deep, 500 feet wide, through the ocean bar, thence up the Cape Fear River, 38 feet deep, 400 feet wide, with increased width at bends, to the upstream end of the anchorage basin (foot of Castle Street) at Wilmington. The anchorage basin at Wilmington is 38 feet deep, 2,000 feet long, 900 feet wide at the upstream end, and 1,200 feet wide at the downstream end. The approaches to the anchorage basin are 1,500 feet long at the upstream end and 4,500 feet long at the downstream end. In the reach from Castle Street upstream to the Hilton Bridge (over the Northeast Cape Fear River), the authorized channel is 32 feet deep, 400 feet wide, with increased widths at bends. In this reach, there is a turning basin opposite the principal terminals at Wilmington, authorized at 32 feet deep, 1,000 feet long and 800 feet wide with suitable approaches at each end. From the Hilton Bridge to the upstream end of the project (1.67 miles above the Hilton Bridge), the channel is 25 feet deep, and 200 feet wide. A turning basin, 25 feet deep, 700 feet long, and 500 feet wide is located 1.25 miles above the Hilton Bridge. Two feet of overdepth is generally authorized throughout the project, except that three feet of overdepth is authorized in areas of rock and at the ocean bar. Figure 1 is a map of the project delineating individual channels.

3.1.2 Past and Present Maintenance. In the early years of the Wilmington Harbor project, most of the material dredged from the channel was deposited on the adjacent river bottoms, using open water deposition by pipeline dredge (section 3.2.1.2). This practice formed many of the islands and flats which are presently found directly adjacent to the channel (e.g. islands 3-13). Since 1972, the islands have been diked to reduce adverse impacts on estuarine resources adjacent to the area of deposition, and to confine dredged sediments so as to reduce shoaling in the downstream areas. At the mouth of the river, the strong currents and often turbulent seas do not **generally** allow the use of a hydraulic pipeline dredge; therefore, diked disposal areas **are** not used. In this area, the hopper dredge (section 3.2.1.1) is currently used with ocean disposal of dredged material.

The current annual estimated amount of shoal sediments from the entire project is approximately 2,300,000 cubic yards. Table 2 lists the annual average volume of dredged material by channel reach.

There are 19 disposal areas in Wilmington Harbor that have been used in the last 20-30 years (table 3, figure 1). Currently, 14 of these disposal sites are used in the Wilmington Harbor project (table 4). Sites 3-10 **are diked disposal sites that** have nearly reached their capacity using the current practice of hydraulic pipeline dredging. **Therefore in the spring of 1988, sections of the channels from Horseshoe Shoal to Big Island channels were maintained by a bucket and barge dredge with ocean disposal of dredged material.**

TABLE 2

Estimated Annual Average Volume of
Maintenance Dredged Material by Reach
(1970-1987)

Annual Average Volume Maintenance Dredged Material (cu yds)	Channel Reach *
820,000	Baldhead Shoal, Smith Island, Caswell-Southport, Southport, Battery Island
Ocean source sediments (above)	
River source sediments (below)	
12,000	Lower Swash
17,000	Snow Marsh
47,000	Horseshoe Shoal
25,000	Reaves Point
26,000	Lower Midnight
118,000	Upper Midnight
45,000	Lower Lilliput
49,000	Upper Lilliput
29,000	Keg Island
8,000	Lower Big Island
3,000	Upper Big Island
31,000	Lower Brunswick
19,500	Upper Brunswick
26,000	Fourth East Jetty
50,000	Between Channel
930,000	Anchorage Basin and Approach
17,500	32' project
10,000	25' project
2,283,000	

* See figure 1 for reach locations.

TABLE 3

Dredged Material Disposal Area Locations, Reaches Serviced, and Dredging Method

	Past					Proposed	
Disposal* Area No.	Location	Approx Size (ac)	Disposal Technique	Reaches Serviced	Dredging Method	Dredging Method**	Disposal Area No.
1	Offshore, **beginning 3 nautical miles south of the mouth of the Cape Fear River**	1950 (2.3 nmi square)	Openwater	Baldhead Shoal, Smith Is., Caswell-Southport, Southport and Battery Island Channels	Hopper	Hopper	1
2	Northwest bank of river opposite Lower Swash	15	Toe of Bank	Lower Swash and Snow Marsh	Pipeline	Hopper or Bucket and Barge	1
3	Between Snows Marsh and the Basin	29	Diked	Snow Marsh and Horseshoe Shoal	Pipeline	Hopper or Bucket and Barge	1
4	Between Snows Marsh and Federal Point	25	Diked	Snow Marsh and Horseshoe Shoal	Pipeline	Hopper or Bucket and Barge	1
5	South of MOTSU	46	Diked	Reaves Point	Pipeline	Hopper or Bucket and Barge	1
6	Due east of Wharf No. 2 at MOTSU	9	Diked	Lower Midnight	Pipeline	Hopper or Bucket and Barge	1
7	Junction of AIWW and Upper Midnight	9	Diked	Upper Midnight	Pipeline	Hopper or Bucket and Barge	1
8	Near junction of Snows Cut and Cape Fear River	47	Diked	Upper Midnight	Pipeline	Hopper or Bucket and Barge	1
9	Due west of Loran Towers	9	Diked	Lower Lilliput	Pipeline	Hopper or Bucket and Barge	1
10	Across the channel from Keg Island	36	Diked	Upper Lilliput and Keg Island	Pipeline	Hopper or Bucket and Barge	1

Table 3 (continued)

	Past					Proposed	
Disposal* Area No.	Location	Approx Size (ac)	Disposal Technique	Reaches Serviced	Dredging Method	Dredging Method**	Disposal Area No.
11	Immediately north of Campbell Island	28	**Not** Diked	Keg Island and Lower Big Island	Pipeline	Hopper, Bucket and Barge or Pipeline	1, 11, or 12
12	North of Upper Big Island	31	**Not** Diked	Upper Big Island and Lower Brunswick	Pipeline	Pipeline	12
13	East of the junction of Upper and Lower Brunswick Ranges	40	**Not** Diked	Lower and Upper Brunswick	Pipeline	Pipeline	13
14	West bank of the river, north of Mallory Creek and south of Brunswick River	28	Diked	Upper Brunswick and 4th East Jetty	Pipeline	Pipeline	15
15	Eagle Island	880	Diked	Between Channel and Anchorage Basin	Pipeline	Pipeline	15
16	Point Peter	40	Diked	32-foot Project	Pipeline	Pipeline	16
17	West side of NE Cape Fear River	10	Diked	32-foot Project	Pipeline	Pipeline	16
18	West bank of NE Cape Fear River	**28**	Partially Diked#	25-foot Project	Pipeline	Pipeline	18
19	East bank of NE Cape Fear River	12	Not diked#	25-foot Project	Pipeline	Pipeline	18

* See figure 1 for disposal area locations.

** A pipeline dredge will be used intermittently over the 50 year period in the reaches from Snows Marsh to Keg Island Channels (inclusive) if capacity is available in the existing disposal islands.

\# Not used for the last **15 years**.

TABLE 4

Capacity and Life Expectancy of Each Disposal Area, Costs and Alternatives

Disposal* Area No.	Capacity (yd3)	Last Used	Expected Life (yr)	Present Dredging Method	Present Cost/yd3	Alternative Dredging Method	Alternative Disposal Area No.	Alternative Cost/yd3
1	Indefinite	1988	Indefinite	Hopper Dredge	$2.30	na	na	na
2	(No longer used, not needed)							
3	200,000	1986	1990	Pipeline	1.60	Hopper Dredge	1	2.30
						Bucket/barge	1	2.30
4	300,000	1986	1990	Pipeline	1.60	Hopper Dredge	1	2.30
						Bucket/barge	1	2.30
5	(No longer used, not needed)							
6	60,000	1970	1988	Pipeline	1.60	Hopper Dredge	1	#
						Bucket/barge		2.80
7	140,000	1985	1990	Pipeline	1.72	Hopper Dredge	1	#
						Bucket/barge		2.80
8	120,000	1985	1990	Pipeline	1.72	Hopper Dredge	1	#
						Bucket/barge		3.00
9	75,000	1985	1990	Pipeline	1.72	Hopper Dredge	1	#
						Bucket/barge		3.00
10	450,000	1981	1990	Pipeline	1.72	Hopper Dredge	1	#
						Bucket/barge		3.00
11	200,000	1977	50 yr	Pipeline	1.30	na	na	na
12	390,000	1970	50 yr	Pipeline	1.30	na	na	na

Table 4 (continued)

Disposal* Area No.	Capacity (yd3)	Last Used	Expected Life (yr)	Present Dredging Method	Present Cost/yd3	Alternative Dredging Method	Alternative Disposal Area No.	Alternative Cost/yd3
13	400,000	1970	50 yr	Pipeline	1.30	na	na	na
14	(No longer used, not needed, Eagle Island near by)							
15**	22,000,000	1987	50 yr	Pipeline	0.85	na	na	na
16	700,000	1981	50 yr	Pipeline	1.90	Pipeline	15	3.00
17	(No longer used, full and surrounded by wetlands)							
18	400,000	##	50 yrs	Pipeline	1.90	Pipeline	15	4.00
19	(No longer used, too small and surrounded by wetlands)							

* See figure 1 for disposal area locations.

** Approximately 1,000,000 yd3 of dredged material will be pumped annually to Eagle Island over the 50 year period. The dredged material is mostly silt and clay with a high water content. When the dredged material is dewatered, the disposal site will have adequate disposal capacity for 50 years.

\# The cost for hopper dredge is unknown but will probably be greater than the cost for bucket and barge dredging.

\## Not used for the last 15 years.

3.1.3 Dredging Schedule. The Anchorage Basin and Between Channel are dredged annually, while maintenance dredging of individual channels in the 38-foot project has usually been performed approximately once every 2 years. The ocean bar channels are dredged by hopper dredge at their current rate of once a year. The segments of the 32 and 25-foot projects are dredged every 4-8 years.

Dredging by hopper dredge in the ocean bar channels is performed any time of the year. Dredging in the rest of the harbor is normally scheduled to take place during the fall and winter months due to the concern over damaging or disrupting estuarine resources during biologically productive periods of the year. Therefore if possible, dredging is avoided from April 1 through September 30. However, the need for dredging has occurred in some reaches of the project intermittently during the April 1 through September 30 time period (see section 3.2.3 for proposed dredging schedule).

3.2 Reasonable Alternatives. During the preliminary screening process, reasonable alternatives were selected which would be environmentally sound, economical, and provide for adequate maintenance of the harbor. Any alternatives which would be environmentally disruptive, such as open water disposal in the estuary were not selected for use. Cost estimates were made for each reasonable alternative to determine the least cost alternative for long-term maintenance. Reasonable alternatives included, depending on the reach, hopper dredge with ocean disposal, bucket-and-barge with ocean disposal, and pipeline dredge to diked disposal areas. The alternatives to be used are indicated in table 3 and described below:

3.2.1 Current and Proposed Dredging Methods.

3.2.1.1 The Hopper Dredge. The seagoing hopper dredge is a self-propelled vessel resembling somewhat the modern ocean tanker in appearance, except for a larger amount of deck equipment. In lieu of the tanks in the latter, the hopper dredge is provided with hoppers used to load and carry material dredged hydraulically from the bottom. It is a completely self-contained dredging plant. The significant characteristic of the hopper dredge is that it operates while underway, requiring no anchors or other mooring devices. They usually work in channels or harbors in which wave action, current, or heavy traffic make a nonself-propelled dredging plant undesirable or impossible. As in any dredging operation, the location of the dredging site, the characteristics of the bottom material, the shape of the waterway, and the availability of usable disposal areas are important factors that affect the economics of hopper dredging and dictate the methods and techniques employed. Hopper dredges are designed primarily to hydraulically dredge materials, load and retain the solids in the hoppers, and then haul them to the disposal site where the material is disposed of by dumping through doors in the bottom of the hoppers or through the hull on the split-hull hopper dredges. Loading is accomplished by sucking the shoal material into the hoppers through a drag head and pipe attached to the side of the vessel as it makes one or more cuts (or passes) through the dredging area. The quantity or volume pumped during the loading operation depends on several variables: the character of the material, the amount of pumping time involved, the hopper capacity, and the pumping and propulsion capability of the dredge being used. During the dredging, the dredged material is pumped on board in a diluted state, with hoppers being equipped with overflows or skimmers to allow decant water to be discharged overboard. Overflowing of the hopper dredge will continue in the ocean bar channels and is proposed in the rest of the harbor where the sediments are predominantly sand (e.g. Snows Marsh, Horseshoe Shoal, Reaves Point, and Upper Lilliput Channels; Section 4.1.3.1).

The loading rate, retention rate, and the time spent in making the round trip to and from the disposal area are important in determining when to terminate loading so as to attain the economic load and economic pumping time. The economic load is determined by a series of load tests conducted periodically during normal dredging and hauling operations.

3.2.1.2 Pipeline Dredge. The pipeline dredge is the most versatile of the hydraulic type dredges. It can handle a large volume of materials economically and can dredge materials from a depth of 60 feet, ranging in consistency from light silt to rock. The dredge, however, is very sensitive to swells and waves; therefore, it is most appropriate for projects in protected waters. Dredging and disposal operations are simultaneous and are conducted when the pipeline dredge is anchored. The materials are removed by the rotary cutterhead through the suction pipe in dilution with water, transported through the main pump, and discharged at the end of the pipeline. The pipeline may range from 6 to 36 inches in diameter but, in North Carolina, 12- to 18-inch pipes are most common. Land disposal is accomplished by adding shore discharge pipes to the floating or submerged pipeline. The length of the discharge pipeline depends on available power but can be extended with booster pumps to a total length of several miles. Increasing the length of the discharge line results in increased costs and often makes it economically infeasible to pump dredged material for long distances. Single stage pipelines, in North Carolina Atlantic Intracoastal Waterway work, range to 10,000 feet. Discharge slurries from cutterhead pipeline dredges generally contain from 10 to 20 percent solids. The rate of sediment removal is dependent upon difficulty in digging, length of discharge pipe, and lift to discharge elevation.

3.2.1.3 Bucket and Barge or Clamshell Dredging. The clamshell dredging procedure consists of the use of a clamshell or bucket, operated from a barge-mounted crane, to excavate shoal materials. A sediment load will be placed by bucket into a bottom dumping barge moored next to the crane. The barge, generally having a 1,000 to 6,000 cubic yard capacity, will be loaded in this manner until it is filled. Once filled, the barge will be transported by tug to the designated ocean dredged material disposal site (ODMDS). At the ODMDS, the bottom of the barge is opened and the dredged material is dumped.

The overfilling of the barges is used to allow decant water to overflow in order to achieve a greater solids load in the barge which results in a more economical load. Barge overflow characteristics are as variable as the size and shapes of the barges being used by the industry. However, two basic overflow methods generally characterize the industry methodology. The most widely used method can best be described as spillover along the sides of the barge to reduce the water inside and increase the quantity of sediment. The second method of overflow uses internal skimmers or overflow weirs that allow the water to flow out of the barge at depths 10 to 15 feet below the surface underneath the hull. The overflow method is economically beneficial when the material being dredged is predominantly sand. The water will tend to have minimal suspended solids and the barge loads will be much more efficient. Therefore, barge overflow is proposed in the reaches of the harbor where the sediments are predominantly sand (e.g. Snows Marsh, Horseshoe Shoal, Reaves Point, and Upper Lilliput Channels, Section 4.1.3.1).

3.2.2 Proposed Dredged Material Disposal. Ocean disposal (as in the past) is proposed for the five lower reaches to be dredged by hopper dredge (Baldhead Shoal Channel, Smith Island Channel, Caswell-Southport Channel, Southport Channel, and Battery Island Channel). The Battery Island Channel rarely needs dredging as the channel remains naturally deep; however, the other four reaches combined require the removal of approximately 820,000 cubic yards annually. The designated ocean dredged material disposal site (ODMDS) is an area 2.3 nautical miles (nmi) square and is located **beginning 3** miles **south of the mouth of the Cape Fear River.** The range of water depth at the disposal site is from approximately 40 to 50 feet. Snows Marsh and Lower Swash rarely require maintenance, but when dredging is required it will be done by a bucket or hopper dredge.

Maintenance of the reaches from Horseshoe Shoal to Keg Island will be by bucket or hopper dredge. Dredged material from bucket and hopper dredging will be deposited in the ODMDS. A pipeline dredge will be used intermittently over the 50 year period in the reaches from Snows Marsh to Keg Island Channels (inclusive) if capacity is available in the existing disposal islands.

A bucket, hopper or pipeline dredge may be used for Lower Big Island with disposal in the ocean disposal site or sites 11 and 12. Maintenance of the channels from Upper Big Island to the upstream end of the project will be by pipeline dredge with **disposal within existing sites 12, 13, 15, 16, and 18.**

Tables 3 and 4 summarize the status and capacity of each of the previously used disposal areas and the proposed alternative(s), if any, to their long term use.

All sites to be used for diked disposal have been completely diked before except for disposal sites 11-13 and 18. These sites will be diked before use. The shorelines on the channel side of islands 11-13 are eroding due to wind waves and boat wakes. There are scattered patches of marsh along the shoreline but most of this marsh is also eroding. The marsh appears to be eroding primarily due to a shoreline slope too steep for successful long-term establishment of marsh and to a lesser degree due to wind waves and boat wakes. In order to **protect the proposed dikes and shorelines from erosion,** the following is proposed:

The shoreline adjacent to each **proposed** dike (approximately 2200 feet per island) will be graded from 10% (the average present slope) down to 3% which is ideal for saltmarsh cordgrass (Spartina alterniflora) establishment. A 50' wide by 2,200' long border of saltmarsh cordgrass would then be planted on 1.5 foot centers in the upper intertidal zone at each island (7.5 acres total for all three islands). A 50' wide border of salt meadow hay (Spartina patens) would then be planted between the mean high water (m.h.w.) line and the toe of the proposed dike at each island (7.5 acres total for all three islands). Wash-out areas that may occur during the first year would be replanted. This planting should not only stabilize the shoreline (e.g. Broome et. al 1981) but create intertidal marsh and high marsh habitat. **This proposed marsh planting action will be coordinated with the appropriate experts and agencies prior to initiation.**

During the grading and diking process, some of the wetlands at the site would be lost; however, there would be a net increase in wetland habitat. See sections 4.2.3 and 5.2.3 for details. All graded material would be removed to the highland portion of the sites and used during dike construction.

Site 18 is a **54.5** acre site, **26.5** acres of which are wetlands (sections 4.2.3 and 5.2.3). Based on current projections, the **28** acre upland portion of the site will be adequate for 50 years of disposal of dredged material. However, **up to 14** acres of wetlands would be needed **for dredged material disposal** if unexpected shoaling occurs. If these wetlands **are needed for disposal of dredged material**, they would be mitigated (section 5.2.4).

A permanent access road is needed to site 18 for equipment to build and maintain dikes, and potentially to be used by trucks in order for New Hanover County to sell the dried dredged material, or if the material is suitable, for daily cover at the county landfill. Removal of the dredged material would reduce the potential need to fill up to 14 acres of wetlands in site 18. The county will attempt to arrange, with the adjacent property owner, for permanent upland road access to the site. If this is not possible, the least adverse impact to wetlands would require the filling of up to 1.0 acre of wooded wetlands. If wetlands are filled for the access road, actions to be taken are indicated in section 5.2.4.

Rediking of all designated disposal sites will take place in a manner which will minimize damages to any existing marsh edge and estuarine areas which surround the sites. This will occur by filling the diked sites, leveling them off at higher elevations, re-diking, and filling them again. Care will be taken in this process not to increase the basal area of the sites, thereby precluding any significant damage to the surrounding estuarine areas. The dikes at each site may be constructed up to 20 feet high mean sea level (m.s.l.) or higher toward the end of the 50 year maintenance period.

3.2.3 Proposed Dredging Schedule. The proposed schedule will be the same as indicated in Section 3.1.3. including the need to dredge intermittently during the April 1 through September 30 time period.

3.3 Summary of Proposed Dredging and Disposal Methods. For the 50 year planning period, the following dredging methods and disposal locations are considered reasonable:

1. A hopper dredge will be used in the reaches from Baldhead Shoal to Battery Island (inclusive) with disposal in the designated ocean dredged material disposal (ODMDS) site.

2. A bucket and barge or hopper dredge will be used from Lower Swash to Keg Island (inclusive) with disposal in the ODMDS.

3. A bucket and barge, hopper or pipeline dredge will be used for Lower Big Island with disposal in the ODMDS or sites 11 and 12.

4. A pipeline dredge will be used from Upper Big Island to the upstream end of the project (inclusive) with disposal in sites 12, 13, 15, 16 and 18.

5. A pipeline dredge may also be used from Snows Marsh to Keg Island reaches (inclusive) for the next several years since capacity is still available in some of the islands adjacent to these reaches (table 4). Also, these islands may be used for disposal of dredged material intermittently over the 50 year period if consolidation of dredged materials provides additional capacity or if the substrate can support higher dikes (section 3.6.4).

3.4 Environmentally Preferred Alternative. All reasonable alternatives were considered environmentally sound and no one alternative was selected as environmentally preferred.

3.5 Alternative Maintenance Methods Eliminated from Further Study.

The following activities were considered but rejected for the indicated reasons:

3.5.1 Disposal in the Estuary and Wetlands. This alternative is not proposed because of its adverse environmental impact and because other alternatives are available that are feasible, provide 50 year disposal capacity and that do not have significant adverse impact on the environment. Adverse impacts associated with estuarine disposal areas could include loss of fish nursery area, shellfish beds and other benthic resources, and recreation areas. Adverse impacts associated with wetland disposal could include loss of breeding and feeding habitat for birds and furbearers, detrital food chain source, and esthetic resources.

3.5.2 Beach **and Littoral Zone Disposal**. The grain size characteristics of the shoal material in the various channels of Wilmington Harbor were evaluated in order to determine the location of shoal material that would be suitable for placement on nearby beaches **or in the littoral zone (ocean area from the surf zone to approximately 25 feet deep).**

3.5.2.1 **Beach Disposal** Alternatives Considered **Using a Hydraulic Pipeline Dredge**. In developing the beach disposal alternative, two beach disposal sites were evaluated in detail, namely: (1) the shoreline fronting the Fort Fisher State Historic Site and (2) the Town of Kure Beach shoreline. In addition, two methods of depositing the material on the beach were considered and were: (1) temporarily storing the material during annual maintenance operations and pumping to the beach on a periodic basis and (2) pumping the material directly to the beach during each maintenance operation. These alternatives have been given the following designation:

A1 - Temporary storage with disposal on Fort Fisher

A2 - Temporary storage with disposal on Kure Beach
B1 - Direct disposal on Fort Fisher
B2 - Direct disposal on Kure Beach

For alternatives A1 and A2, temporary storage would be on disposal areas 3 or 4 (figure 1). Every 10 years the stored material would be pumped to Fort Fisher or Kure Beach for beach disposal. For alternatives B1 and B2, the dredged material would be pumped directly to either Fort Fisher or Kure Beach during the dredging operation. Only the section of the navigation project between Lower Swash and Reaves Point channels had grain sizes suitable for beach disposal. The total average annual volume of shoal material removed from these channels is 101,000 cubic yards of which 12,000 cubic yards is removed from Lower Swash channel, 17,000 cubic yards from Snow Marsh channel, 47,000 cubic yards from Horseshoe Shoal channel, and 25,000 cubic yards from Reaves Point channel (table 2).

Due to the extremely long pumping distance from Lower Swash channel to the beach disposal sites or to a temporary storage area and the relatively small quantity of material removed from this channel, Lower Swash channel was not included in the beach disposal alternative evaluation. For these same reasons, the lower portion of Snow Marsh channel was also excluded. The volume of material that would be available for placement on the beach from the remaining channels; which include Reaves Point, Horseshoe Shoal, and the upper portion of Snow Marsh is estimated to be about 89,000 cubic yards/year. Of this total, 25,000 cubic yards/year would be obtained from Reaves Point channel, 47,000 cubic yards/year from Horseshoe Shoal, and 17,000 cubic yards/year from the upper portion of Snow Marsh.

None of **these four** alternatives are considered economically feasible when compared to bucket and barge operation (table 5). Additional information on **these alternatives are** in Appendix B of the **final** EIS.

An investigation was performed for the alternative of a hydraulic pipeline dredge pumping the sand removed around the mouth of the river to the beaches at Baldhead Island. The hydraulic pipeline dredge would only be used in the reaches closest to Baldhead Island (most economical pumping distance), but a hopper dredge would still be needed for the remainder of the lower harbor. The costs would be higher than hopper dredge operations alone because of extensive periods of time when the pipeline dredge could not operate efficiently in the rough inlet environment and the increased costs associated with mobilization and operation of two dredges (USACE 1989).

For any of the above alternatives involving disposal on a beach, if the State requests that the sand be placed on a beach, the sand will be placed there if the local sponsor pays 50% of the additional pumping costs, all necessary environmental clearances are obtained and the provisions of USACE EC 1165-2-142 (cost sharing for disposal of material on beaches) are met.

If an agency or group other than the State desires to have the sand placed on a beach, this sand will be made available if the agency or group (1) pays all the additional pumping costs, (2) obtains all necessary environmental

TABLE 5

Average Annual Costs for Beach Disposal and Ocean Disposal by Bucket and Barge for the Snow Marsh to Reaves Point Channels

Disposal Alternative	Average Annual Cost
A1 Fort Fisher Disposal	$806,000
A2 Kure Disposal	$936,000
B1 Fort Fisher Direct	$560,000
B2 Kure Direct	$771,000
Bucket and Barge	$205,000

clearances, (3) the State does not request that the sand be placed on another beach and (4) pumping the sand to the beach would not adversely impact the USACE dredging schedule.

3.5.2.2 <u>Pumping to the Beach from a Hopper Dredge</u> This alternative was considered for pumping the sand removed around the mouth of the river to the beaches at Bald Head Island or Oak Island. However, the cost of this alternative would be up to $4.12 a cubic yard more than ordinary hopper dredge operations. The costs would depend on the size of the dredge and whether the dredge is government owned or a contract dredge. If the State, an agency or group desires this sand be placed on a beach, the provisions indicated in section 3.5.2.1 must be met.

3.5.2.3 <u>Littoral Disposal by Bucket and Barge Operations</u>. The dredged material considered for this alternative would come from the Reaves Point to Lower Swash channels which would normally be disposed in the ODMDS. The annual maintenance volume for these channels is 101,000 cubic yards. Material dredged upriver of these ranges is unsuitable for littoral disposal due to the high clay content and the downriver reaches are dredged by hopper dredges (Bucket and barge operations could also be used in much of the lower reaches to be maintained by hopper dredge, but the cost comparison and effectiveness would be similar to that indicated below). To attempt to dispose of dredged material in the nearshore zone would require an increase in the round trip distance of 9 nautical miles (compared to disposal in the ODMDS) to reach the closest feasible disposal area, Long Beach (Long Beach is more feasible than Baldhead, Caswell or Yaupon Beaches since the barges can get closer to the beach at Long Beach versus the other beaches). The increased distance is required because a loaded barge can not cross the shoals adjacent to the nearshore ocean portion of the navigation channel. The greater distance would increase the dredging cost by $0.50 per cubic yard or $50,000 per year.

The depth of the disposal area would be 24-25 feet (loaded barge draft is 22 feet). This is near the seaward end of the littoral zone. The amount of material from littoral disposal moving toward the beach would probably be less than 25% and quite likely would be much less than 25%. If 25% of the material moves on the active profile, the effective additional cost of the material would be $2.00 per cubic yard. If only 10% moves shoreward, the effective additional cost would be $5.00 per cubic yard. If an agency or group desires to have the sand placed in the littoral zone, then the sand could be made available if the agency or group (1) pays all the additional costs, (2) obtains all necessary environmental clearances, (3) the State does not request that the sand be placed on a beach and (4) placing the sand in the littoral zone would not adversely impact the USACE dredging schedule.

3.5.3 <u>Ocean Disposal by Pipeline</u>. This alternative assumes that material removed from Lower Lilliput to Lower Swash channels is pumped by pipeline to a point 5000' offshore of Fort Fisher. Average pumping distances from these reaches to the beach at Fort Fisher is 36,000' (41,000' total to offshore disposal point) and could require as many as three booster pumps. Based on the average annual maintenance volume of 309,000 cubic yards using a 27" pipeline dredge, the average annual cost just to reach the beach would be $6,207,000. Compared to the annual costs of $1,070,000 for bucket and barge dredging for the same reaches, the ocean disposal by pipeline alternative is not economically feasible. Additional information on this alternative is in appendix B of the final EIS.

3.5.4 Disposal in Upland Disposal Areas Not Previously Used for Disposal of Dredged Material. This alternative is not proposed because of its adverse environmental impact and because other alternatives are available that are feasible, provide 50 year disposal capacity and that do not have significant adverse impact on the environment. Adverse impacts associated with upland disposal areas could include loss of diverse terrestrial habitat, elimination of the associated fauna, potential of contamination of groundwater by saltwater, and adverse impacts on esthetic resources.

3.5.5 Best Management Practices. The main purpose of best management practices (BMP) is to reduce erosion of topsoil from agricultural lands. BMP's include no till farming, grassed waterways and grassed field borders. Similar techniques such as grassed road shoulders and drainage ditches are also frequently used along highways and in urban areas to control erosion. The Corps of Engineers encourages the use of BMP's wherever possible; however, regardless of the extent of use, BMP's only reduce erosion, they do not stop it. Therefore sediment will still enter the river. This sediment along with the existing bedload in the river, will always create a need for extensive maintenance dredging. Since maintenance would still be required if BMP's were fully implemented, a detailed analysis of this alternative was not performed.

3.5.6 Moving the State Port Terminal to the Mouth of the Cape Fear River. Comments during the study suggest that harbor maintenance could be minimized by relocating the NC State Ports facilities to the mouth of the Cape Fear River. This alternative has many difficulties, including the lack of available upland, no rail lines in the area, inadequate highway connections, and the distance from labor markets and shipping service companies. Also about 45 percent of the cost of maintaining the harbor occurs at the ocean bar, which would continue to require the same maintenance regardless of location of terminal facilities along the river. The NC State Ports handles only about one-half of the tonnage for the harbor, and about half the NC State Ports tonnage is handled through facilities which are leased to others (principally Paktank and Koch Fuels). Deep draft shipping would still be required by oil terminals, Almont Shipping, W. R. Grace, Chemserve, Dixie Cement, and other terminals. The cost of relocating all deep-draft facilities to downstream areas would be tremendous and environmentally disruptive.

3.5.7 No Action. The alternative of no action would mean that the authorized project would be allowed to return to its natural depth over time and economic benefits due to the project would slowly decrease until they no longer existed. At some future point, when sediment had built up in the channel, medium and deep draft navigation would be impossible.

In view of the tremendous historic, economic, and social impacts the abandonment of Wilmington Harbor would have on the region, the State, and the Nation, and since economically and environmentally sound alternatives are available for harbor maintenance, the choice of no action is not reasonable.

3.6 Other Actions Considered.

3.6.1 Maintenance of the Harbor for the Military Ocean Terminal, Sunny Point. The Military Ocean Terminal, Sunny Point (MOTSU), is located adjacent to the Wilmington Harbor channel approximately 15 miles downstream from Wilmington. MOTSU is operated by the Military Traffic Management Command with a mission to support the U.S. Armed Forces and Allies through the transfer of military cargoes from land-based transportation to ocean-going carriers. The maintenance of adequate depths in the MOTSU berthing areas, turning basins, and access channels is prerequisite to maintaining a high state of military preparedness at the facility.

The maintenance of MOTSU harbor facilities is not included in this long-term evaluation of Wilmington Harbor because of the unique military mission and maintenance requirements of the MOTSU facility. However, environmental analysis specific to the MOTSU maintenance dredging program indicate that ocean disposal of MOTSU dredged material is the only currently available, environmentally acceptable long-term disposal alternative. Rehabilitation of existing diked upland disposal areas and sand borrow areas on the MOTSU property may provide disposal capacity for a limited number of dredging operations; however, other non-ocean disposal alternatives are not available.

3.6.2 Maintaining the Two Existing Colonial Waterbird Nesting Islands and Creating a Third Nesting Island. The two existing colonial waterbird nesting islands (figure 1) are only large enough (**maximum of 4 acres per island**) to provide sufficient disposal capacity on an intermittent basis. However, the District remains committed to the management of the two existing colonial waterbird nesting islands in the lower Cape Fear River through the intermittent placement of dredged material. An environmental assessment discussing such activities was prepared and distributed to all known interested parties in December, 1982 (USACE 1982).

It has been suggested that a third island in the lower river would be beneficial to the colonial waterbird population and facilitate future management. The District does not plan to pursue this option as other sites are available that have the necessary environmental clearances. However, if other agencies or interests obtain all necessary environmental clearances and perform any necessary site preparation, the District will provide dredged material to create and maintain the island in conjunction with it's regularly scheduled maintenance dredging events.

3.6.3 Controlling Erosion on Existing Disposal Islands. **As indicated in section 3.2.2, the undiked disposal islands 11-13 are eroding due to wind waves and boat wakes. In addition, three diked** Wilmington Harbor disposal areas are eroding **(4, 8 and 10)**. The most severe erosion is occurring at disposal area 8. All 3,000 feet of the 20-foot high (m.s.l.) dike fronting the channel is eroding. The erosion is caused by waves striking the base of the dike during the high stage of the tide. The dike material that sloughs from the disposal area is redistributed by waves and currents. An estimate of cost for erosion protection using a stone rubble revetment was made. This type of structure has proven to be the most reliable and economical over the years. Based on nationwide demonstration projects, rubble bank protection projects range in price from $140 to $525 per foot of bank protected. A rubble shore protection structure on Pamlico Sound was recently designed and had an estimated cost of $425 per foot of shoreline. Using this rate per linear foot for disposal area 8 yields a cost for erosion protection of $1,275,000.

The remaining capacity in disposal area 8 is estimated to be 120,000 cubic yards. The cost saving obtained by using disposal area 8 ($1.72/cy) versus using ocean disposal ($2.80/cy) is $1.08 per cubic yard or $130,000. Erosion protection by stone rubble is clearly not economically feasible. Similarly, preventing erosion at the other two diked disposal areas is either not economically feasible or the amount of erosion is so minor that action at this time is not warranted.

Controlling erosion by planting marsh (similar to sites 11-13) at sites 4, 8 and 10 is not feasible due to the capacity of each site that would be lost to establish an appropriate slope for marsh planting.

3.6.4 A Preliminary Stability Analysis for Disposal Area Dikes. A preliminary analysis for the Eagle Island disposal area (site 15) dike, which was based on standard design and construction techniques, has been completed. The use of toe berms, flatter side slopes, and/or geotextiles and any other possible methods of increasing the dike height will be investigated during the final design analysis in order to assure that the dike capacity is maximized. The maximum dike height will be limited due to an undesirable foundation condition at the site. Periodically the dike will need to be raised to accommodate settlement. Repairs to the dike should be expected, and will be necessary as a part of the continuing maintenance of the dike. After the dike construction is completed, any modification to the dike will reanalyzed. Dike height should be adequate to provide a 50 year disposal capacity.

A similar analysis will be performed at the other disposal sites if or when dikes need to constructed or raised.

3.6.5 Periodic Review of the 50 Year Maintenance Plan, New Technology and Unexpected Circumstances.

Periodic Review of Maintenance Plan. It is recognized that modifications to the proposed action may be necessary during the 50 year period due to changes in dredging technology, shoaling rates, environmental conditions or laws and regulations. Therefore, the maintenance plan will be reviewed every five years. The first review period will be five years from the publication of the final EIS. All interested Federal, state, and local agencies, groups and the public will be invited to participate in these reviews.

New Technology. Potential for new dredging and disposal technology does exist. More efficent dredges could be developed that would remove sediment more effectively and cause fewer undesirable environmental impacts. Some prototype pipeline dredges are being developed that could pump material further than previously expected and at lower cost.

Unexpected Circumstances. While some Federal project channels have been deepened by private interests, it is difficult to predict the timing and location of other improvements. An example of work by private industry is the deepening of the Federal navigation channel from 32 feet to 35 feet by Stevedores, Incorporated over about 1.7 miles extending from the upper end of the 38-foot channel at the Cape Fear Memorial Bridge to a point in the Northeast Cape Fear River just downstream of the N.C. 133 Highway Bridge. This work was completed in February 1978 after the necessary State and Federal permits were issued. Chemserve Terminal, Incorporated deepened approximately 1,000 feet of the Federal navigation channel from 25 to 30 feet between the Hilton Bridge and their docks. The modification of existing State and Federal permits was approved in February 1985 and the deepening was completed in December 1985.

3.7 Other Existing Navigation Projects in the Area. Continued maintenance of the Wilmington Harbor project is completely compatible with all other Federal navigation projects in the area. The following Federal navigation projects are directly or indirectly dependent upon the continued maintenance of the harbor:

Northeast Cape Fear River, N.C.
Smiths Creek (Wilmington), N.C.
Cape Fear River, N.C., above Wilmington
Black River, N.C.
Military Ocean Terminal at Sunny Point (MOTSU)
Atlantic Intracoastal Waterway
U.S. Coast Guard Station access channel at Oak Island

There are no incomplete or planned projects in the Wilmington Harbor area that will be adversely affected by the continued maintenance of the harbor. Modifications to the Wilmington Harbor project are being considered which are discussed below.

3.8 Anticipated Harbor Expansion. The elements recommended in the Wilmington Harbor - Northeast Cape Fear River, N. C. Feasibility Report and covered in the revised final EIS (both published in December 1979 and reprinted as H. D. 98-185) have been authorized by Congress (P.L. 99-662). The Wilmington District is currently conducting a preconstruction engineering and design study on this project. If constructed, the project elements that will require long term maintenance include the following: widening the Fourth East Jetty Channel by 100 feet and deepening to 38 feet; widening the Northeast Cape Fear River turning basin by 100 feet, and deepening the channel from the Cape Fear Memorial Bridge (Castle Street) to a point approximately 750 feet upstream of the Hilton railroad bridge to 35 feet. The current projection is to initiate construction in FY 1991.

The North Carolina State Ports Authority (NCSPA) has requested the Corps of Engineers to develop plans for a passing lane approximately half way between the NCSPA terminal at Wilmington and the mouth of the Cape Fear River, widening the turning basin near the NCSPA terminal from 1,200 feet to 1,500 feet, and widening various turns and bends in the navigation channel. All of these improvements would help to remove constraints on the use of the largest size container ships. The studies **on these improvements** should be complete in 2-3 years.

If these projects are constructed, a 50 year maintenance plan will be developed for each.

3.9 Ability to Meet Navigation and Maintenance Needs for 50 Years and Local Sponsors' Responsibilities. If the project is maintained as proposed, the authorized Wilmington Harbor project will have adequate dredged material disposal area to maintain authorized project dimensions for the next 50 years. Therefore, navigation needs in the harbor will be met.

The maintenance dredging costs for this project are 100% Federal but the local sponsors are responsible for providing disposal areas for maintenance of the project and diking costs, if any. The local sponsor for the 38-foot section of the harbor is the State of North Carolina and the local sponsor for the 32-foot and 25-foot sections of the harbor is New Hanover County. The local sponsors have fully complied with their responsibilities in the past and all of the land required for the 50 year maintenance plan (except site 18) are owned by the USACE or local sponsors. New Hanover County officials **recently acquired site 16 and** are currently in acquisition negotiations with the owners **of site 18.**

4.0 AFFECTED ENVIRONMENT.

Since this EIS deals only with the maintenance of an authorized project, only the aspects of the environment that will be potentially impacted by the reasonable dredging and disposal alternatives indicated in section 3.2 will be discussed.

4.1 Significant Resources.

4.1.1 Geology and Mineral Resources (see also Appendix C). Various soil sample borings were drilled in the Wilmington Harbor project area, in the Cape Fear River and dredged material disposal areas, to ascertain the viability of several alternatives for the disposal of dredged material. Twenty-one borings consisting predominantly of standard penetration test (splitspoon) and shelby tube sampling were drilled. Fourteen of these borings were drilled at various places on and inside the dike at the Eagle Island disposal area (site 15) for a stability analysis of the dike in anticipation of raising the dike for future needs. Dredged material disposal area 10 had two borings, one splitspoon hole and one shelby tube hole drilled. The remainder of the borings were drilled in dredged material disposal areas 3 and 4 and in the river between these disposal areas and the river channel to determine if the material was suitable for beach disposal.

Soils Encountered. Soils encountered at Eagle Island consist of the following types:

SOIL TYPE	UNIFIED SOILS CLASSIFICATION SYMBOL
1. Sandy silt	ML
2. Poorly graded sand	SP
3. Inorganic silt	MH
4. Organic silt	OH
5. Clayey sand	SC
6. Fat Clay	CH
7. Silty Sand	SM
8. Poorly graded sand to a silty sand	SP/SM

Most of these soil types represent dredged material from the Between Channel and the Anchorage Basin, while some are in situ material such as that encountered in the subsurface at Eagle Island.

Below the dredged material at Eagle Island is an organic silt (OH) with abundant roots and wood. The dredged material overlying the OH is mostly ML, SP, and MH. The OH soil can probably be attributed to the rapid burial of an ancient grassland or woodland. This soil probably represents original ground. The high organic content of the soil contributes to the instability of the sediment under load condition. Below this OH is a greyish clayey sand (SC) or a poorly graded brown or grey sand (SP). These soils are not subject to consolidation in comparison to the organic OH with wood and roots.

Soils encountered in dredged material disposal areas 3, 4, and 10 in the Cape Fear River consist of ML, SP, SP/SM, SM. The dredged material comes from the navigational channel between Snows Marsh and Horseshoe Shoal (areas 3 and 4) and Upper Lilliput and Keg Island (area 10).

4.1.2 Seismology. The Wilmington Harbor area is situated in a seismic Zone 1 (relatively inactive). About five earthquake epicenteres dating from the years 1871 to 1968 are located around New Hanover County ranging from intensity III to V on the Modified Mercalli scale. Three of these are intensity V. The area is relatively aseismic.

4.1.3 Sediments and Grain Size Analysis.

4.1.3.1 Channel Reaches. The general grain size characteristics of the channel reaches for ocean disposal are indicated in table 6. The grain size for the remaining channels range from 61% sand and 39% silt/clay in the lower Brunswick reach to >99% sand in the 25' project near disposal site 18 (USACE 1977).

4.1.3.2 Ocean Dredged Material Disposal Site (ODMDS). The Wilmington ODMDS is a site designated by EPA pursuant to Section 102(c) of the Marine Protection Research and Sanctuaries Act of 1972, as amended, as an ocean location where ocean dumping of dredged materials may be permitted. The Wilmington ODMDS received final designation as an EPA approved ocean dumping site on August 3, 1987 (52 FR 25008 et seq.).

The Wilmington ODMDS lies just beyond the 3 nmi limit of the territorial sea. The site encompasses an area of approximately 2.3 square nmi. Bathymetric surveys of the Wilmington ODMDS indicate a very flat ocean floor gently sloping from north to south from 36 to 46 ft below mean low water (m.l.w.). The sediments within the ODMDS are predominately sands with small quantities of shell, silts and clays.

4.1.4 Water Resources.

4.1.4.1 Groundwater. There are three groundwater sources in the Wilmington Harbor/New Hanover County area. At the top is the water table aquifer of the surficial sand. Below the surficial sand is the aquitard, Canepatch formation. Below the Canepatch is the aquifer of the Waccamaw and Bear Bluff, i.e. marine sands. The aquifer below the Waccamaw and Bear Bluff is the Castle Hayne Limestone. There is an undetermined amount of connection between the Waccamaw/Bear Bluff and the Castle Hayne aquifers. Most domestic water wells are set in the surficial sands. The second most used aquifer is the Castle Hayne limestone.

Locally, vertical groundwater movement may occur downward through the surficial sand, through the discontinuous aquitard, through the marine sand aquifer, to the Castle Hayne.

TABLE 6

Characteristics of river sediments proposed for
Bucket and Barge and Hopper Dredging

Station No. - Channel	% Gravel	% Sand	% Silt & Clay
		% By Weight	
1 - Caswell-Southport	18.0	80.5	1.5
2 - South Southport	16.0	82.0	2.0
3 - North Southport	9.0	89.0	2.0
4 - Battery Island	38.0	61.0	1.0
5 - Lower Swash	27.0	70.0	3.0
6 - Horseshoe Shoal	0.0	98.0	2.0
7 - Reaves Point	0.0	99.0	1.0
8 - Lower Midnight	0.0	76.0	24.0
9 - Upper Midnight	0.0	82.5	17.5
10 - Lower Lilliput	0.0	53.5	46.5
11 - Upper Lilliput	0.0	98.0	2.0
12 - Keg Island and Lower Big Island	0.0	63.0	37.0

Note: Gravel - grain size larger than 5.0 mm
Sand - grain size between .07 & 5.0 mm
Silt and clay - grain size smaller than .07 mm

All samples were collected using a Petersen grab sampler from within the channel limits. Samples 1-5 above were taken March 20, 1986 and samples 6-12 were taken July 2, 1986.

Snows Marsh channel sediment was sampled May 3, 1976, and Smith Island and Baldhead Shoal channels were sampled during April 1979 with the following results:

	% Gravel	% Sand	% Silt & Clay
Baldhead Shoal channel			
offshore reaches	0.0	73.2	26.8
inlet reaches	0.0	98.7	1.3
Smith Island	7.9	92.0	0.1
Snows Marsh channel	0.0	99.0	1.0

Regionally the horizontal groundwater movement is eastward with some southeast movement. The resultant groundwater movement picture is that of movement to the coast, upward movement, and lateral movement. Because of confining clays and silts for the most part there are not large artesian springs like in Florida (LeGrand 1984).

Most disposal islands proposed for use (3-4, 6-13, and 15) are surrounded by tidal saltwater, and sites 16 and 18 are bordered by the Cape Fear River and Northeast Cape Fear River, respectively. For all these sites, the groundwater gradients are into the river and dredged disposal materials from the river have chloride contents equal to or less than that of the river in the vicinity in which they are disposed.

4.1.4.2 Surface Water.

Hydrology, Wave, Climate, and Saltwater Intrusion. The drainage area for the Cape Fear Estuary is 9,140 square miles. The average daily freshwater flow is 9,700 cfs. The estuary is well mixed except during large freshets when the estuary becomes partially mixed. The location of the zone of mixing between fresh and saltwater varies between the mouth of the Cape Fear River and Wilmington. Its exact location depends on the magnitude of the freshwater inflow and the tidal range. The average tidal range is about four feet. Surface waves 3 feet or less are typical within the estuary.

In 1987, the State of North Carolina performed a brief study of the problem of recent (circa 1982 - 1987) tree mortality in the swamps of the lower Northeast Cape Fear River estuary. That study concluded that tree death in the affected areas was attributable to high levels of salinity in the river. Recent site inspections by the Corps (January and May 1988) found that tree mortality was evident throughout the lower Northeast Cape Fear River estuary. Salinity stress was noted on Smith Creek to a point approximately 1.5 miles upstream of the Southern Coastline Railroad (SCLRR) bridge. On the Northeast Cape Fear River, the upstream limit was a point approximately 4 miles above the SCLRR bridge (figure 1). All tributary streams between Smith Creek and the upstream limit on the Northeast Cape Fear River have been similarly affected.

Salinity damage to trees is often first noticed as leaf injury and ultimately leads to defoliation. The tree species most affected by the salt water encroachment to date are bald cypress (*Taxodium distichum*), tupelo gum (*Nyssa aquatica*), sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), ash (*Fraxinus sp.*) and oaks (*Quercus sp.*). The salinity tolerances of these species and other species occurring in the swamp forests of the area are not well documented but are assumed to be quite low. Some work on salinity tolerances of freshwater wetland species of plants has been done. Pezeshki et al. (1987a) found that stomatal conductance and net photosynthesis of bald cypress seedlings declined significantly at salinities as low as 2 parts per thousand (ppt)(approximately 1,091 mg chloride/L). Similarly, significant reductions in stomatal conductance and net photosynthesis have also been reported for green ash (*Fraxinus pennsylvanica*) seedlings with salinities at approximately 1.95 ppt (1,064 mg chloride/L) (Pezeshki and Chambers 1986) and for maidencane (*Panicum hemitomon*) with salinities ranging from 5 to 7 ppt (approximately 2,754 to 3,862 mg chloride/L) (Pezeshki et al 1987b).

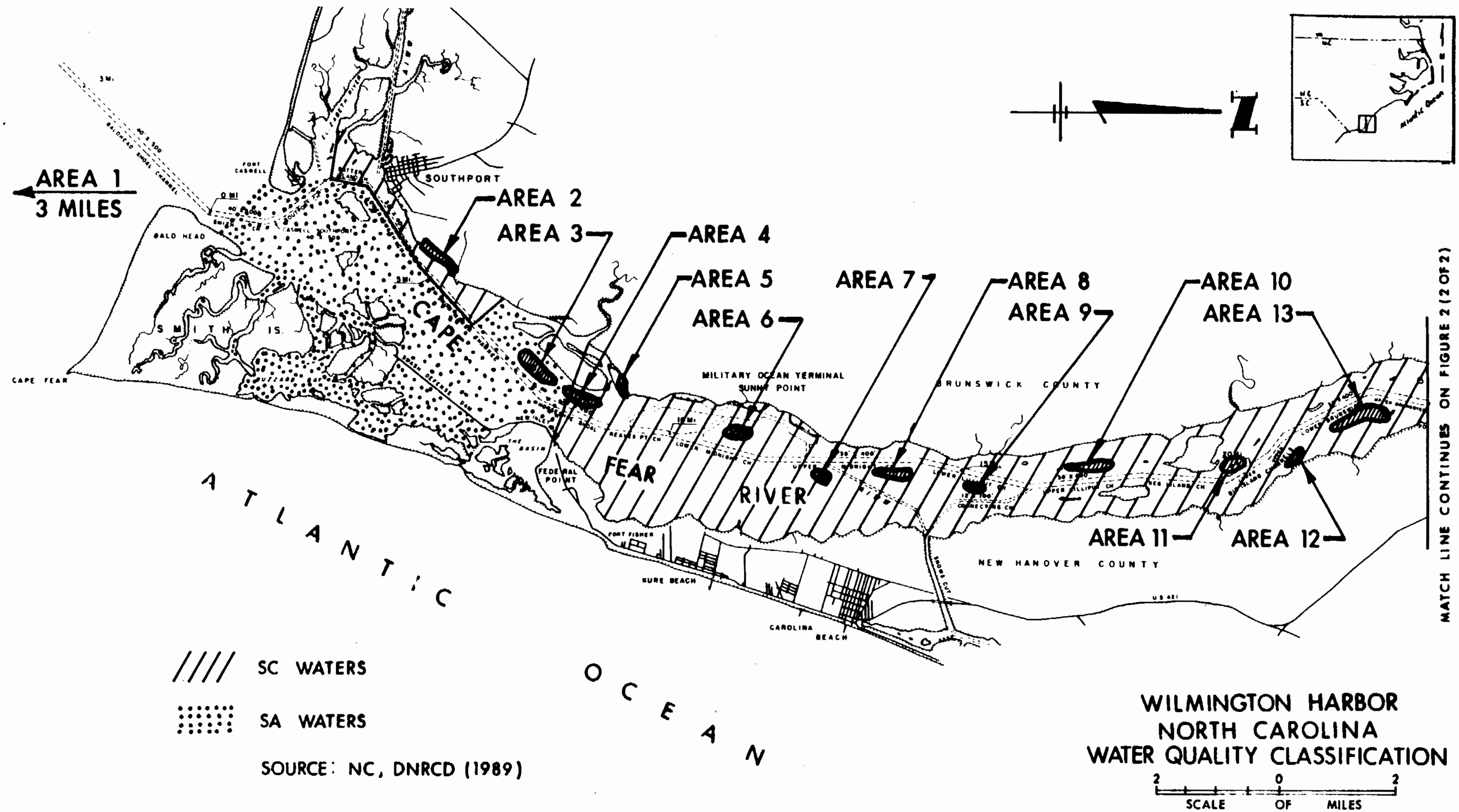
A recent study performed in the Cape Fear River in the project area has demonstrated that major changes in the salinity regime have occurred in the past and that these changes are attributable to rising sea level and to navigation improvements (Hackney and Yelverton, in press). Both of these factors allow ocean derived salts to encroach further upstream due to increased tidal amplitude.

Water Quality Classification. The North Carolina Division of Environmental Management has placed the lower Cape Fear and Northeast Cape Fear Rivers into three separate water classifications (NC Department of Natural Resources and Community Development 1989). From the the northern limits of the project in the Northeast Cape Fear River to the Cape Fear River is "SC-swamp waters"; the Cape Fear River at the mouth of the Northeast Cape Fear River to a line across the river between Snows and Federal Points is "SC"; and the Cape Fear River at the line across the river between Snows and Federal Points to the Atlantic Ocean is "SA" (except for a segment west of the Cape Fear River Channel that is classified "SC"). See figure 2 for details. "SC" waters are suitable for fishing, fish and wildlife propagation, secondary recreation, and other uses requiring water of lower quality. "Swamp waters" means that these streams generally have slow velocities. "SA" means that in addition to the uses in "SC", the waters are acceptable for shellfishing for market purposes and the water will meet accepted sanitary standards of water quality for outdoor bathing places and will be of sufficient size and depth for primary recreation purposes. The water quality standards for these waters are published by the NC Department of Natural Resources and Community Development (NCDNRCD 1986a).

Due to various sources of pollution, some of the waters in the lower river are indicated as prohibited (closed) shellfish areas (figure 3). This means no person shall take or attempt to take any oysters or clams or possess, sell, or offer for sale any oysters or clams from those areas.

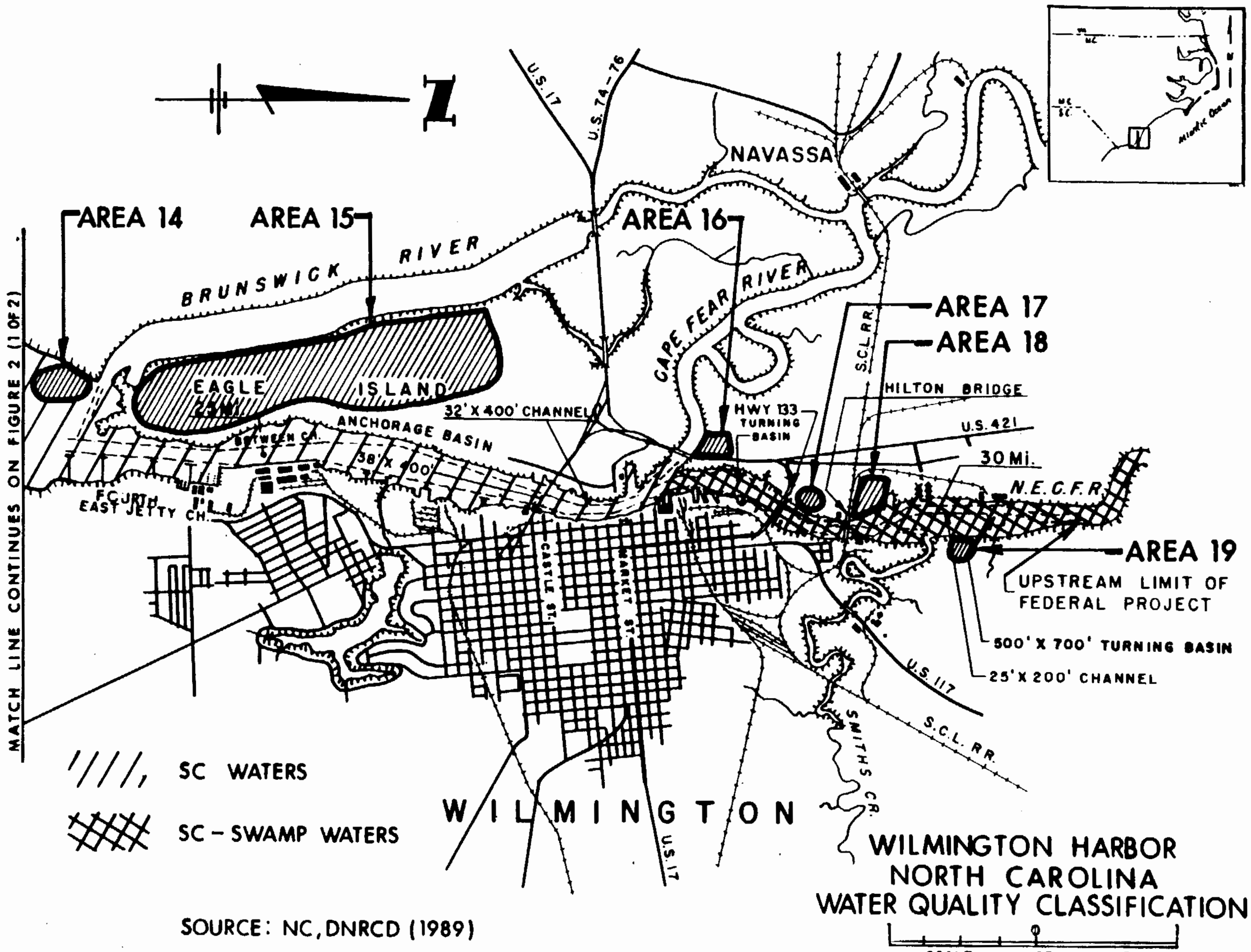
Analyses of Wilmington Harbor Sediments for Ocean Disposal. In accordance with EPA's Ocean Dumping Regulations and Criteria (40 CFR Part 227.13), samples of bottom sediments in the Wilmington Harbor project (Keg Island and Baldhead Shoal channels) have been tested to evaluate the toxicity and bioaccumulation potential of chemical contaminants which may be associated with those sediment materials (US Army Corps of Engineers 1980, and 1986a). The test results (USACE 1980 and 1986a) indicate that the sediments meet the testing criteria of the EPA Ocean Dumping Regulations and Criteria and are, therefore, acceptable for transportation for ocean dumping under Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972, as amended. (The Keg Island sediments are assumed to be representative of the sediments in the reaches from Lower Midnight to Lower Big Island channels, inclusive.)

The grain size characteristics of the river sediments in the area where ocean disposal of dredged material is possible are given in table 6.



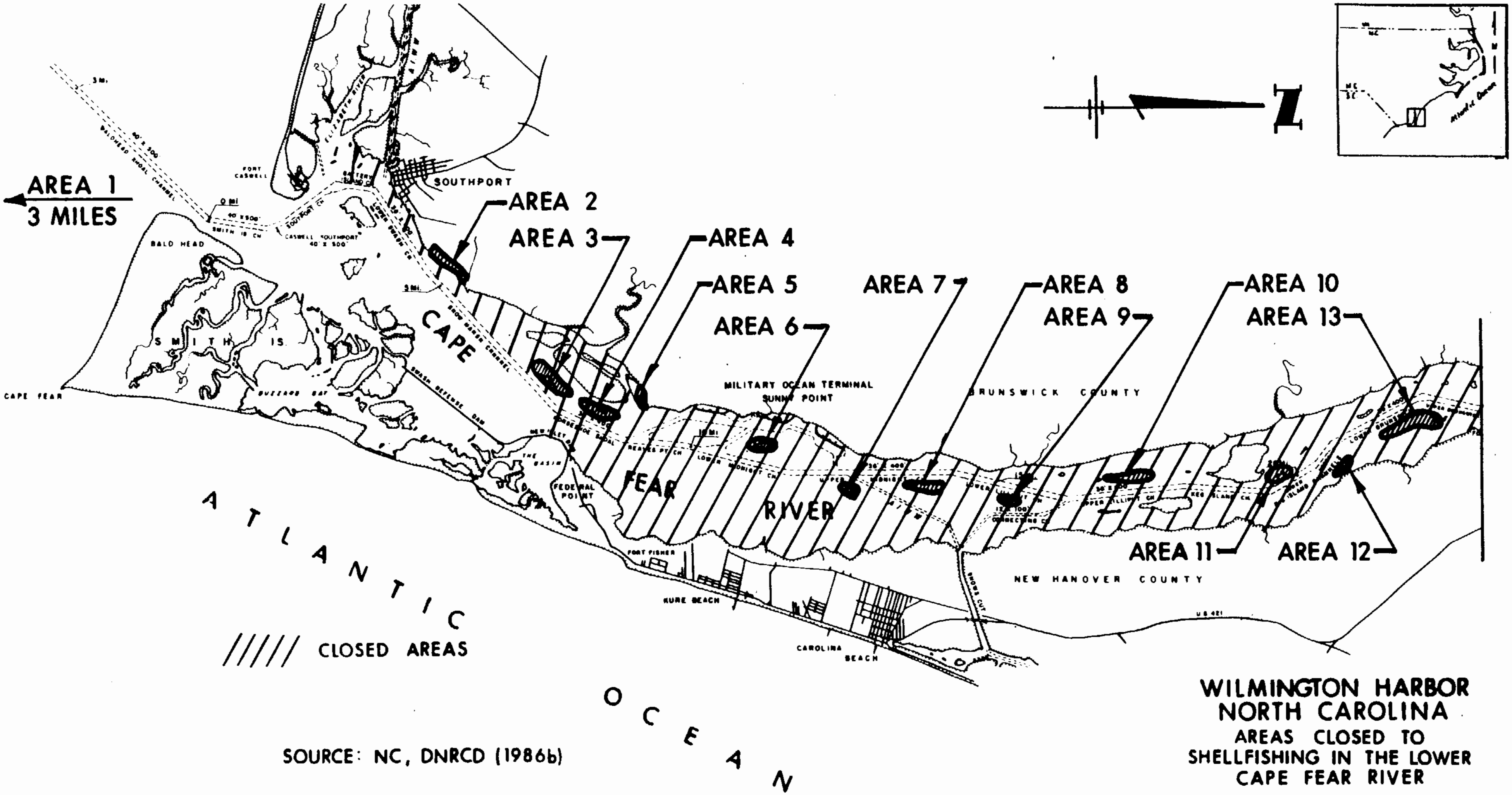
WILMINGTON HARBOR
NORTH CAROLINA
WATER QUALITY CLASSIFICATION

FIGURE 2 (1 of 2)



WILMINGTON HARBOR
NORTH CAROLINA
WATER QUALITY CLASSIFICATION

FIGURE 2 (2 of 2)



WILMINGTON HARBOR
NORTH CAROLINA
AREAS CLOSED TO
SHELLFISHING IN THE LOWER
CAPE FEAR RIVER

FIGURE 3

Sediments from Smith Island, Caswell-Southport, Southport, Battery Island, Lower Swash, Snow Marsh, Horseshoe Shoal and Reaves Point channels were sampled for grain size analyses and were found to be composed of predominantly sand or coarser grained materials; therefore, sediments from these channels were considered acceptable for ocean disposal without further testing (40 CFR Part 227.13 (b)(1)).

Therefore, USACE concluded that all the channels from Baldhead Shoal to Lower Big Island, inclusive, were acceptable for disposal in the ODMDS. USEPA, Region IV, concurred with this conclusion (January 23, 1987 letter and October 19, 1987 memo.).

Future testing required for continued approval for ocean disposal of Wilmington Harbor dredged materials is not known; however, it is likely that re-testing of sediments from reaches proposed for ocean disposal will be required over the next 50 years.

4.2 Biology of Dredging and Disposal Sites.

4.2.1 Aquatic Biology Including Ocean Disposal Sites.

4.2.1.1 Nekton. Schwartz et al., (1981) reported the collection of 249 species of fish from a 1973-1980 survey of the saline lower Cape Fear River watershed. Their study area included parts of the Northeast Cape Fear River, the Cape Fear River downstream of Lock and Dam 1, and the adjacent Atlantic Ocean off Baldhead and Oak Islands. The Cape Fear estuary including the adjacent Atlantic Ocean is characterized, however, by a few species which occur very abundantly and others which occur only incidentally (CP&L, 1980).

The nekton of the Cape Fear estuary are dominated by species residing in the estuary as larvae or juveniles, using the estuary as nursery or feeding habitat, but spawning offshore in the Atlantic Ocean (Birkhead et al., 1979). Abundant species in the "nursery use" category include Atlantic menhaden, *Brevoortia tyrannus*; Atlantic croaker, *Micropogon undulatus*; spot, *Leiostomus xanthurus*; star drum, *Stellifer lanceolatus*; penaeid shrimp; mullet, *Mugil spp.*; and weakfish, *Cynoscion regalis*. Species that are estuarine endemics or permanent residents are also abundant, namely, bay anchovies, *Anchoa mitchilli*; killifishes, *Fundulus spp.* ; and silversides, *Menidia spp.* (Weinstein, 1979). Anadromous species such as blueback herring, *Alosa aestivalis*; American shad, *Alosa sapidissima*; hickory shad, *Alosa mediocris*; alewife, *Alosa pseudoharengus*; striped bass, *Morone saxatilis*; and Atlantic sturgeon, *Acipenser oxyrhynchus* use the Cape Fear estuary as a transportation route to upper river spawning and nursery areas (Walburg and Nichols, 1967; Nichols and Louder, 1970). The catadromous American eel, *Anguilla rostrata* is widely distributed in the Cape Fear River estuary (Schwartz et al., 1981).

The nekton of the ocean waters in the area of the Wilmington Harbor ODMDS and along the southeastern North Carolina coast can be placed into three categories: estuarine dependent species; seasonal, north-south or warm water migrant species; and permanent resident species. The most abundant nekton of these nearshore marine waters are the estuarine dependent species such as sciaenid fish, including croakers; spot; weakfish; star drum; red drum, Sciaenops ocellatus; banded drum, Larimus fasciatus; mullets; flounders, Paralichthys spp.; and penaeid shrimp (Struhsaker, 1969; Schwartz et al., 1981). Some species are permanent residents of the nearshore marine waters and may include the black sea bass, Centropristis striata; longspine porgy, Stenotomus caprinus; Atlantic bumper, Chloroscombrus chrysurus; inshore lizardfish, Synodus foetens; and searobins, Prionotus spp. Common warm water migrant species include bluefish, Pomatomus saltatrix; spanish and king mackerel, Scomberomorus maculatus and S. cavalla; cobia, Rachycentron canadum; Florida pompano, Trachinotus carolinus; and spiny dogfish, Squalus acanthias.

4.2.1.2 Benthos. According to Birkhead et al. (1979), benthic density in the lower Cape Fear region was highest in the nearshore ocean rich organic sediment and lowest in the sandy estuarine areas. Downstream of MOTSU, the dominant organisms were polychaetes especially a spionid polychaete (Spiophanes bombyx). Other abundant organisms were the little surf clam (Mulinia lateralis), sea pansy (Renilla reniformis), mud snails (Ilynassa obsoleta) and brittlestars (subclass Ophiuroidea).

Lawler, Matusky & Skelly Engineers (1975) conducted a benthic investigation at six stations ranging from near the mouth of the Cape Fear River up to the mouth of Smith Creek in the Northeast Cape Fear River near the upper end of the project. Polychaetes dominated the benthic fauna below MOTSU. Of the 21 species collected, only five species occurred above site 8 and only one species at Smith Creek. Species included (Scolecolepides virdis), (Capitella capitata), (Branchioasylis americana), (Drilonereis longa) and (Nereis succinea). Oligochaetes were the most abundant group in the entire river, comprising 35% of all collected fauna. They were most abundant from Campbell Island to the Anchorage Basin. Amphipods (Gammarus spp.) occurred in all samples but were most abundant near MOTSU, the Anchorage Basin and at Smith Creek. Other common species collected were Cumaceans and Isopods.

Woodward-Clyde Consultants (1980) surveyed the benthos in the vicinity of the anchorage basin. Nematodes, the spionid polychaete (Scolecolepides viridis), and the isopod (Chiridotera almyra) were dominant in the medium-fine sand. The silty clay substrate was dominated by the oligochaete (Peloscoles benedeni) and by an amphipod (Gammarus sp).

Shellfish beds are also present in the Cape Fear Estuary, primarily south of Snows Cut (Woodward-Clyde Consultants 1980). All significant beds are in shallow water east of the ship channel. The dominant species are the American oyster (Crassostrea virginica) and the clam (Mercenaria mercenaria). In this area, both species are harvested for sale and personal consumption.

4.2.1.3 Plankton. Carpenter (1971) studied phytoplankton populations in the Cape Fear estuary and nearby ocean waters. Carpenter found the diversity to be greater at the mouth of the estuary than in either the coastal waters or the upriver areas. The dominant phytoplankton was the diatom Skeletonema costatum. Other common species included the diatoms Asterionella japonica and Thalassionsina nana, the dinoflagellate Katodinium rotundatum, and the loricate flagellate Calycomonas ovalis. Birkhead et al. (1979) indicated that diatoms were more abundant in the ocean and flagellates more abundant in the estuary.

According to Birkhead et al. (1979), the calanoid copepods (Acartia tonsa and Paracalanus crassirostris) and barnacle nauplii were the dominant taxa comprising zooplankton samples in the Cape Fear estuary and nearshore ocean waters. Other organisms consistently present were bivalve veligers, copepod nauplii, cyclopoid copepods, crab zoea, gastropod veligers, and polychaete larvae. Densities of zooplankton tended to be greater in the ocean than in the estuary.

4.2.1.4 Estuarine Nursery Areas. As discussed previously, the most abundant nekton species in the Cape Fear estuary are those species residing in the estuary as larvae or juveniles and using the estuary as nursery or feeding habitat. The Cape Fear estuary nursery areas can be divided into 3 broad ecological zones:

1. Deep water of higher salinity in the turbulent lower reach of the estuary.

2. Deep channel and channel slopes within the Cape Fear River.

3. Shallow areas including marshes, oyster reefs, mud flats, marsh rivulets, and tidal creeks (CP&L. 1980).

Individual species appear to have specific choices of nursery sites especially in terms of temperature, depth, salinity, and substrate type (Weinstein et al., 1980). Hodson (1979) found larval anchovies; silversides, Menidia sp.; killifishes; gobies, Gobionellus sp.; pinfish, Lagodon rhomboides; spot, mullet; and penaeid shrimp had centers of abundance in the shallow, marsh rivulets of the Cape Fear estuary. Larval croakers and menhaden seem to favor the open waters of the main river shoals and channels (Weinstein, 1979). Generally, with increasing size, juveniles or yearlings move from their preferred nursery area into the deeper waters of the larger creeks and bays, eventually into the deeper water of the lower estuary and offshore to spawning areas (Purvis 1976).

Copeland et al. (1979) described two periods of larval and postlarval abundance in the Cape Fear estuary. A winter-spring period, approximately December through April, corresponds to the recruitment into the estuary of ocean spawned species including spot, croaker, flounder, menhaden, mullet, and brown shrimp (Penaeus aztecus). A summer period, approximately May through September, corresponds to the recruitment of estuarine or ocean spawned species such as anchovies, trout, gobies, and white and pink shrimp (Penaeus setiferus and Penaeus duorarum, respectively).

The Wilmington Harbor Channel from Upper Lilliput upstream to its terminus extends through areas designated by the N.C. Division of Marine Fisheries as "primary nursery" areas (15 NCAC 3B .1405). However, 300 yards east and west of the centerline of the main shipping channel from Upper Lilliput Channel to the mouth of the Brunswick River is excluded from the primary nursery area designation. The State of North Carolina defines primary nursery areas as those areas in the estuarine system where initial post-larval development takes place.

4.2.2 Terrestrial Biology

4.2.2.1 Flora. Disposal areas planned for use during the maintenance of the project were mapped in order to identify and delineate the vegetation communities present and to assess the affects of the project on wetland areas and wildlife habitat. These maps are presented on figures 4 - 20 and acreages indicated in table 7. Due to the disturbed nature of most of the sites, vegetative types often occur in complex mosaics and were difficult to define in terms of community types. In order to simplify the identification and mapping process, only the community types of institutional significance (Section 404 (PL 95-217) wetlands) were defined in detail while those of lesser concern were combined into broader categories. The following is a brief description of the community types mapped for this analysis.

BARREN (b) - These are areas with little or no vegetation. On some of the dredged material disposal areas, these areas are large expanses of sand. This community is located at higher elevations than the surrounding wetlands.

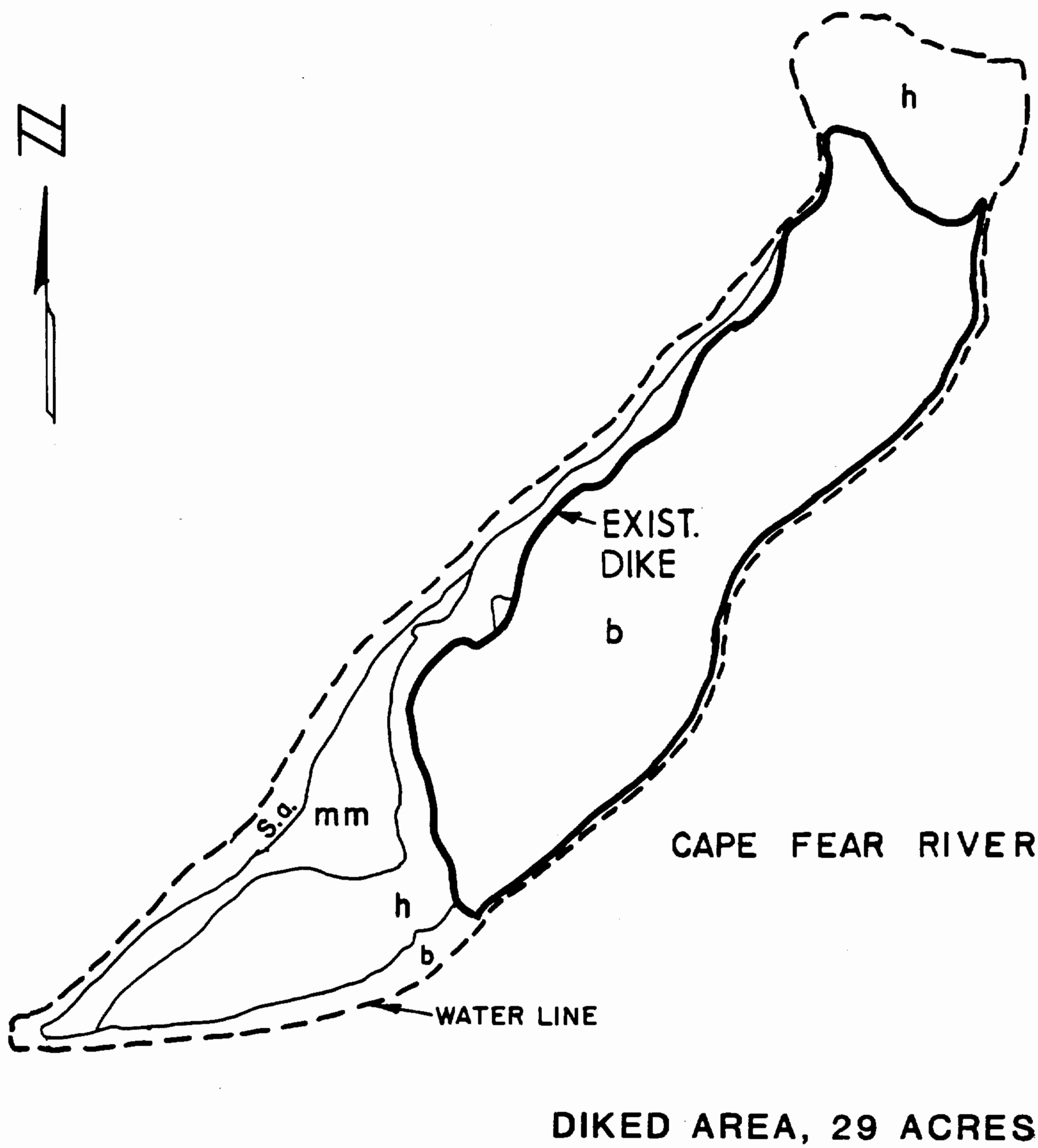
MIXED FOREST (mf) - This community is generally present in the higher elevations of the existing dredged material disposal areas and is characterized by mixed tree species. Some common species include: Live oak (*Quercus virginiana*), loblolly pine (*Pinus taeda*), black cherry (*Prunus serotina*), red maple (*Acer rubrum*) and common cottonwood (*Populus deltoides*).

SHRUB (sh) - These are communities characterized by a predominance of low (height up to 15 or 20 feet) woody plant structures. Dense shrub growth sometimes forms nearly impenetrable thickets. This community is found above the mean high water elevation. Plants commonly found in this community are goundsel tree (*Baccharis halimifolia*), marsh elder (*Iva frutescens*), wax myrtle (*Myrica cerifera*), yaupon (*Ilex vomitoria*) and blackberry (*Rubus* spp.).

SPARTINA ALTERNIFLORA (S.a.) - This wetland community is dominated by saltmarsh cordgrass (*Spartina alterniflora*) and grows on the intertidal flats which surround most of the dredged material disposal islands. It is tolerant of a wide range of salinities.

PHRAGMITES AUSTRALIS (P.a.) - This is a monotypic community of common reed (*Phragmites australis*). This species grows rapidly to a height of 10 to 12 feet and excludes almost all other vegetation. It grows at all elevations in the existing dredged material disposal areas.

TYPHA SP. (T.sp.) - This community is found at lower elevations in areas of low salinity and consists of cattails (*Typha angustifolia* and/or *Typha latifolia*).



SEE FIGURE 1 FOR LOCATION.

LEGEND

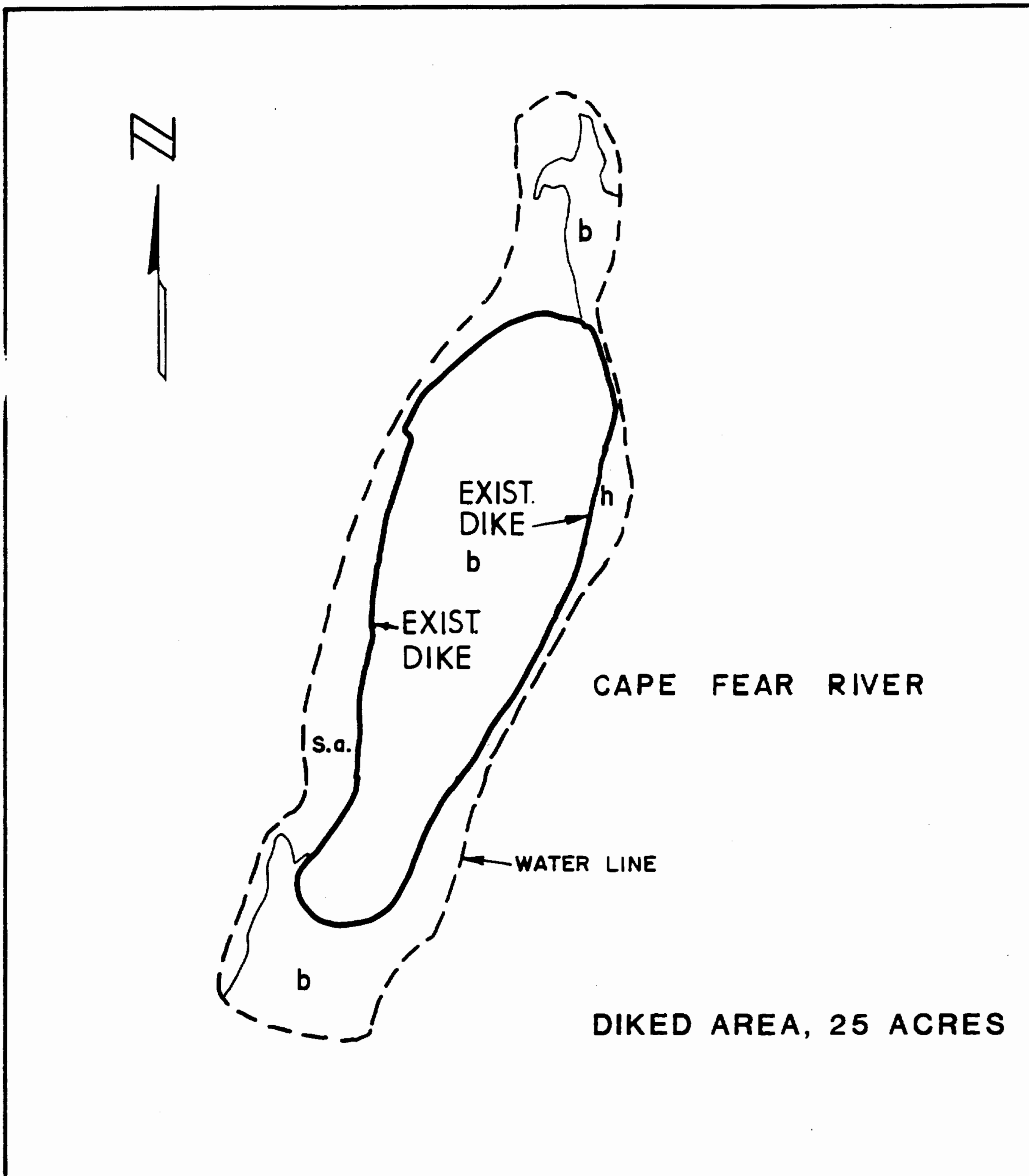
b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 3
VEGETATION MAP
FIGURE 4

0 250 500
SCALE IN FEET



SEE FIGURE 1 FOR LOCATION

LEGEND

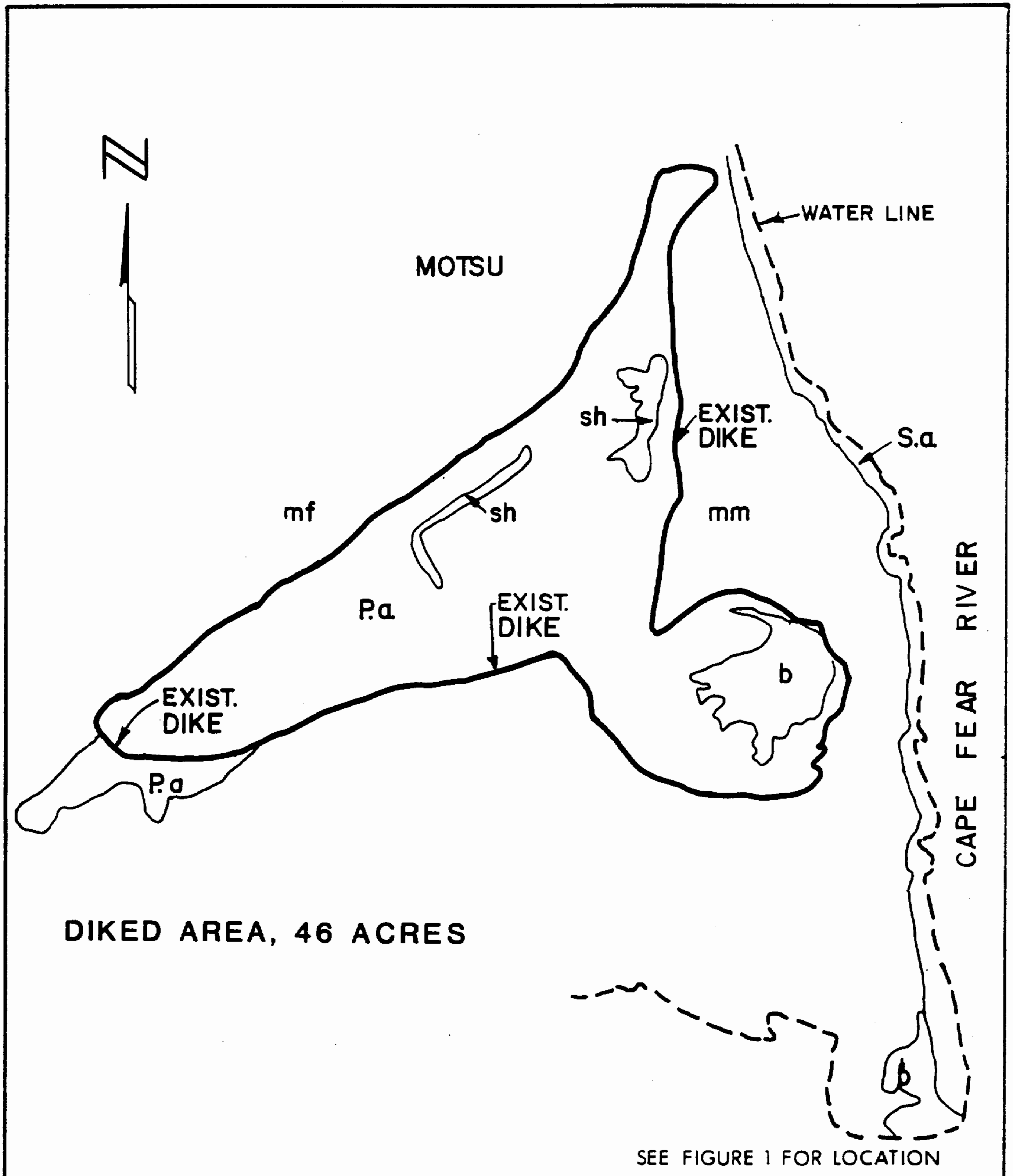
b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 4
VEGETATION MAP
FIGURE 5

0 250 500
SCALE IN FEET



LEGEND

b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON
4/85 PHOTOGRAPHY

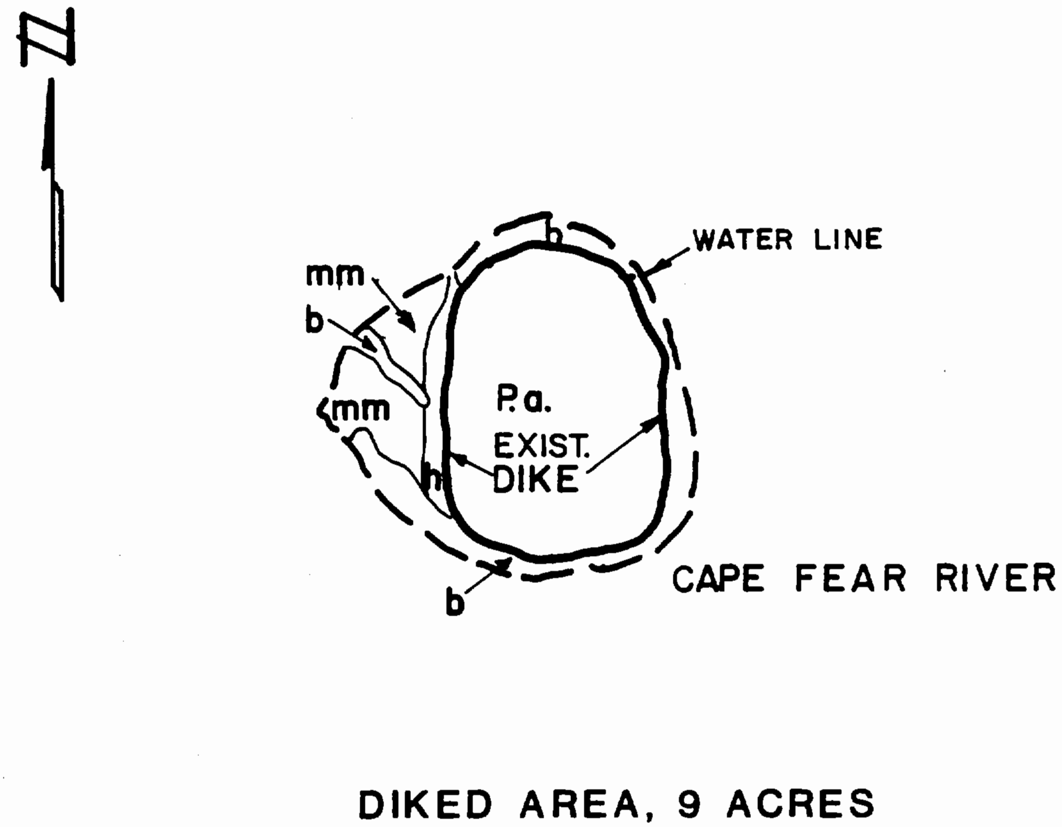
WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 5

VEGETATION MAP

FIGURE 6

0 250 500
SCALE IN FEET



SEE FIGURE 1 FOR LOCATION

LEGEND

b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

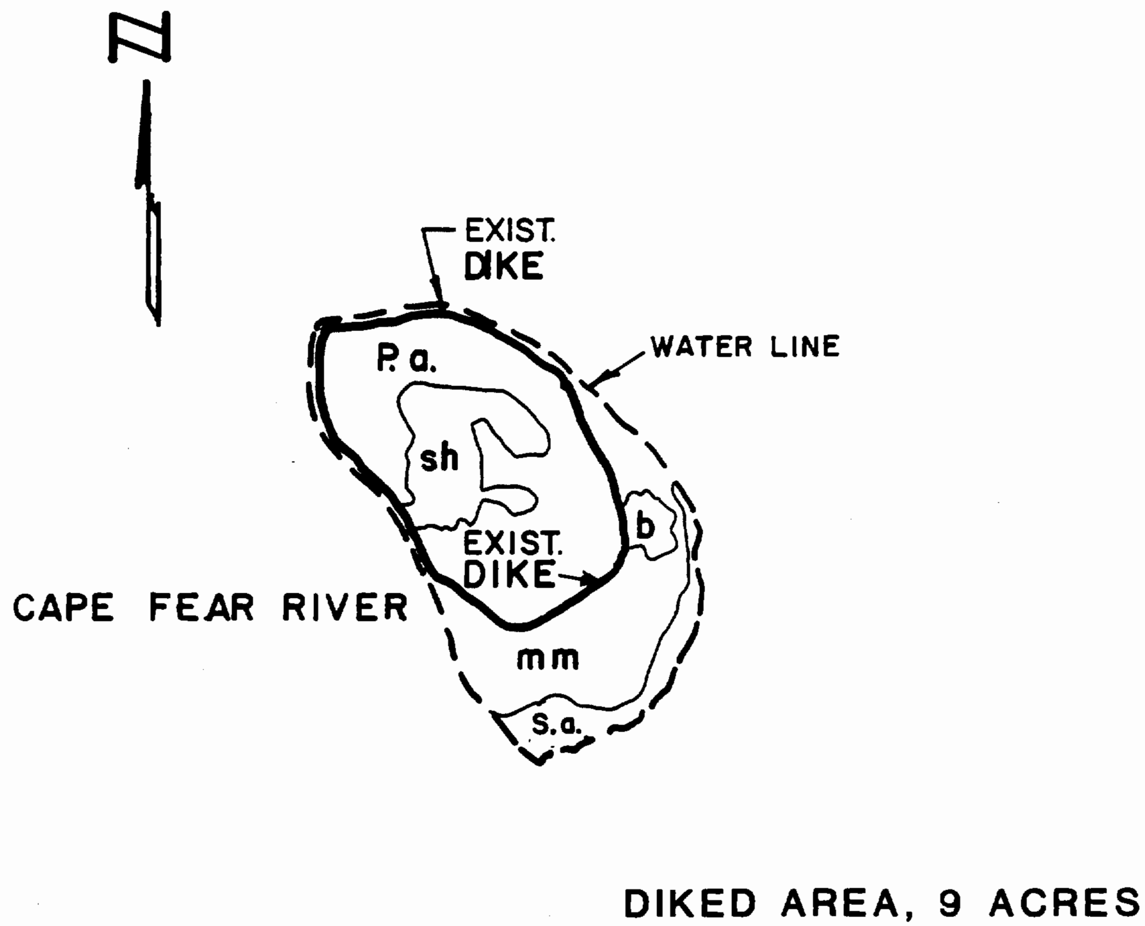
MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 6
VEGETATION MAP

FIGURE 7

0 250 500
SCALE IN FEET



SEE FIGURE 1 FOR LOCATION

LEGEND

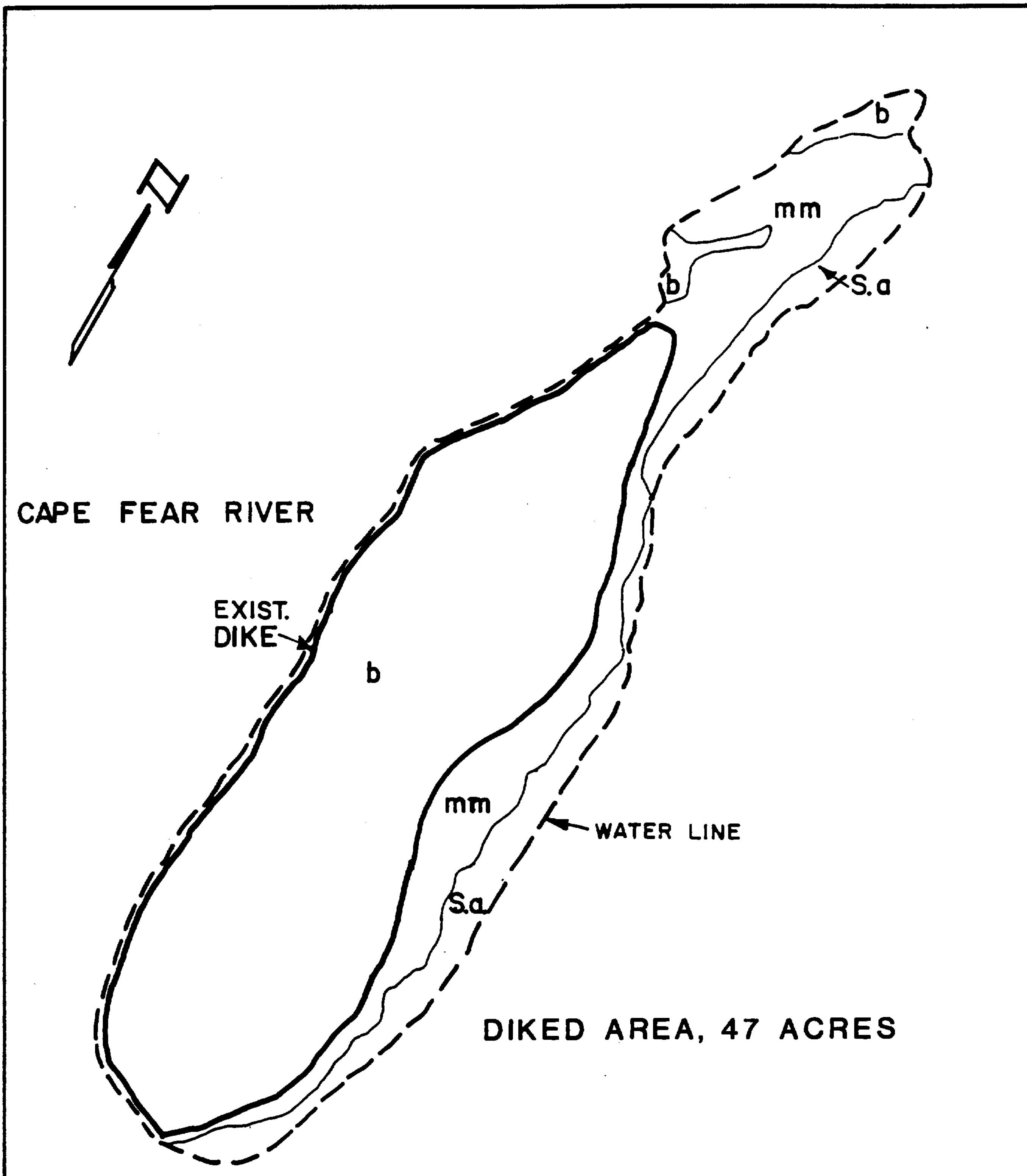
b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 7
VEGETATION MAP
FIGURE 8

0 250 500
SCALE IN FEET



SEE FIGURE 1 FOR LOCATION.

LEGEND

b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

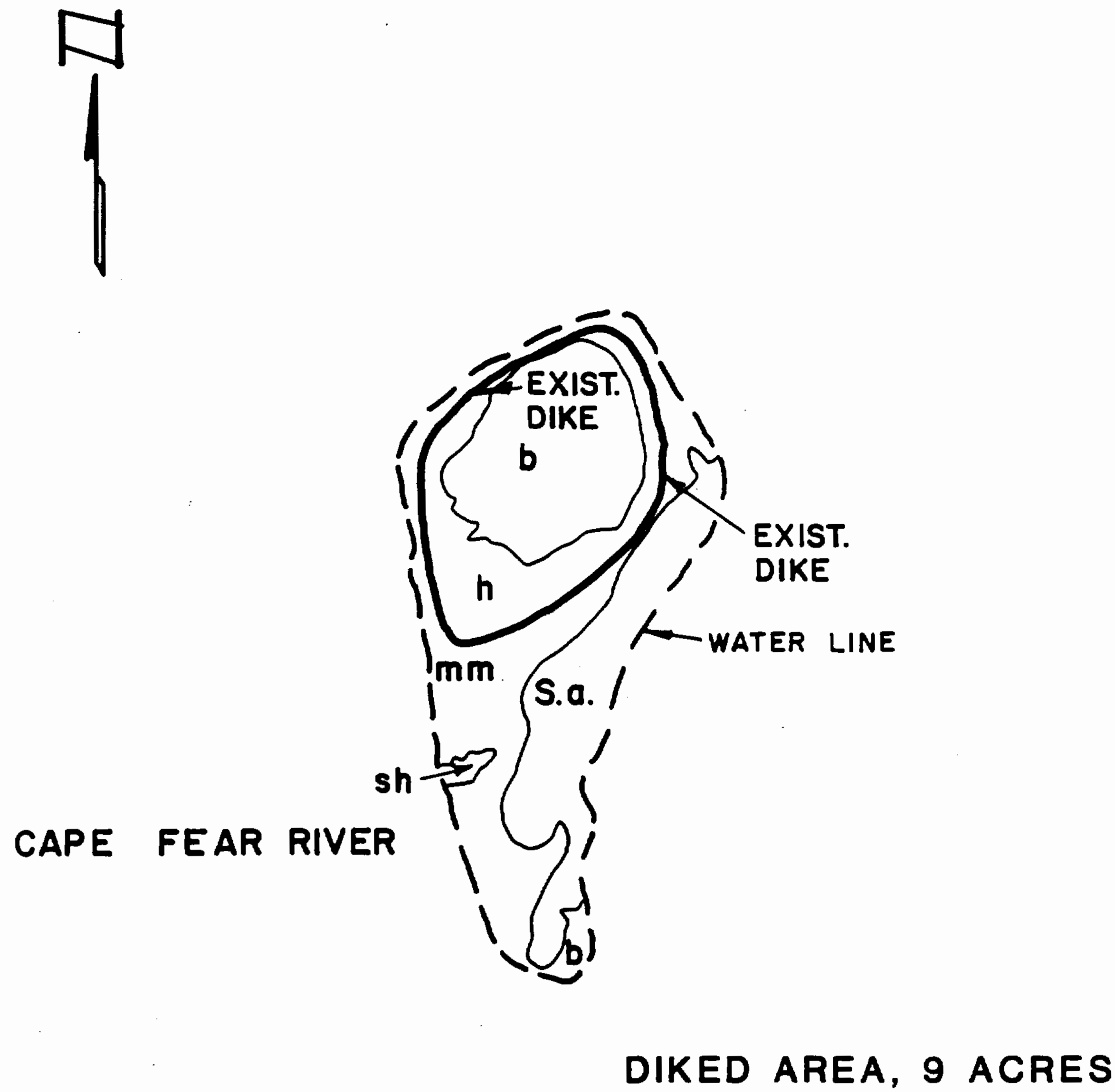
MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 8
VEGETATION MAP

FIGURE 9

0 250 500
SCALE IN FEET



SEE FIGURE 1 FOR LOCATION

LEGEND

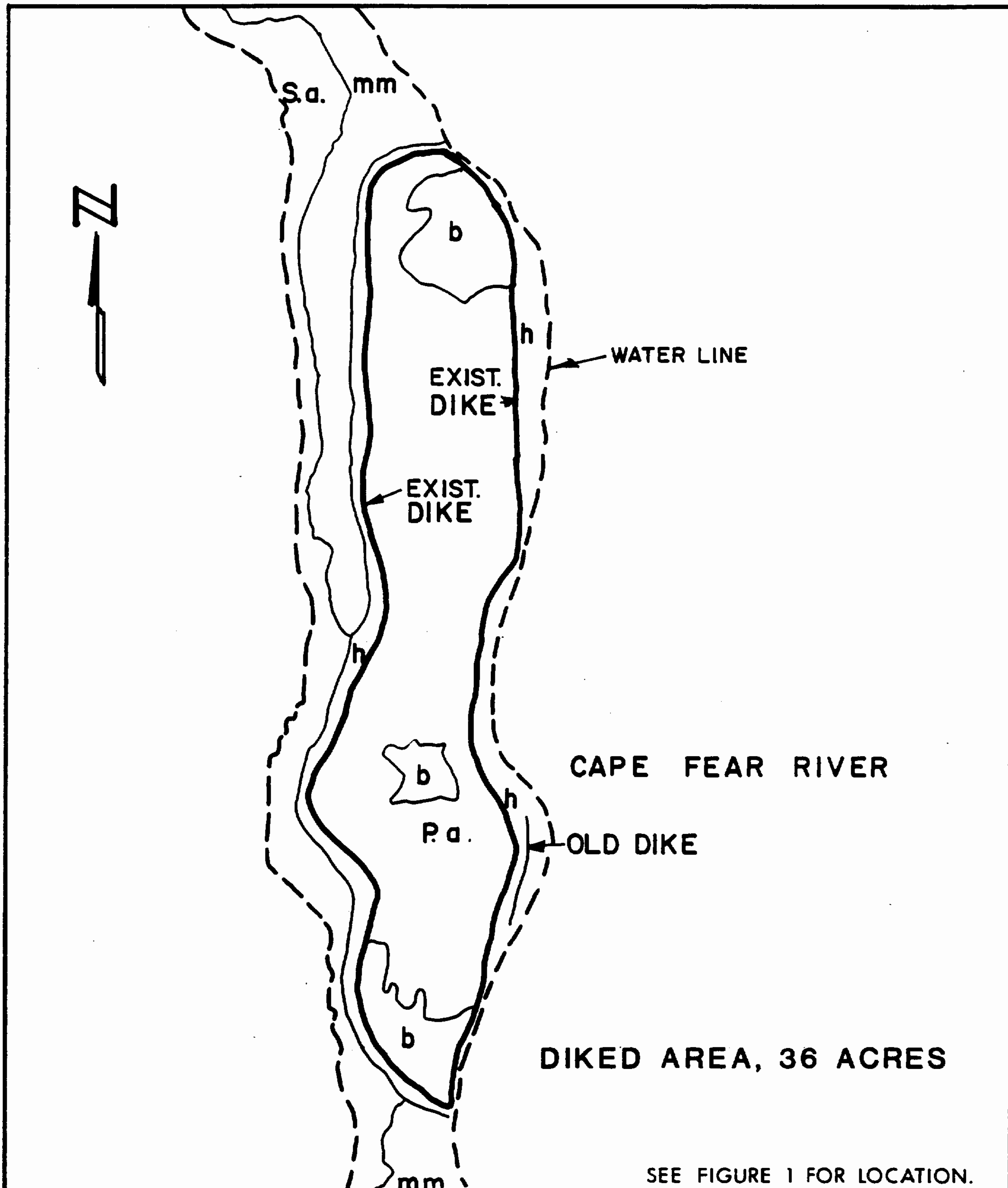
b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 9
VEGETATION MAP
FIGURE 10

0 250 500
SCALE IN FEET



LEGEND

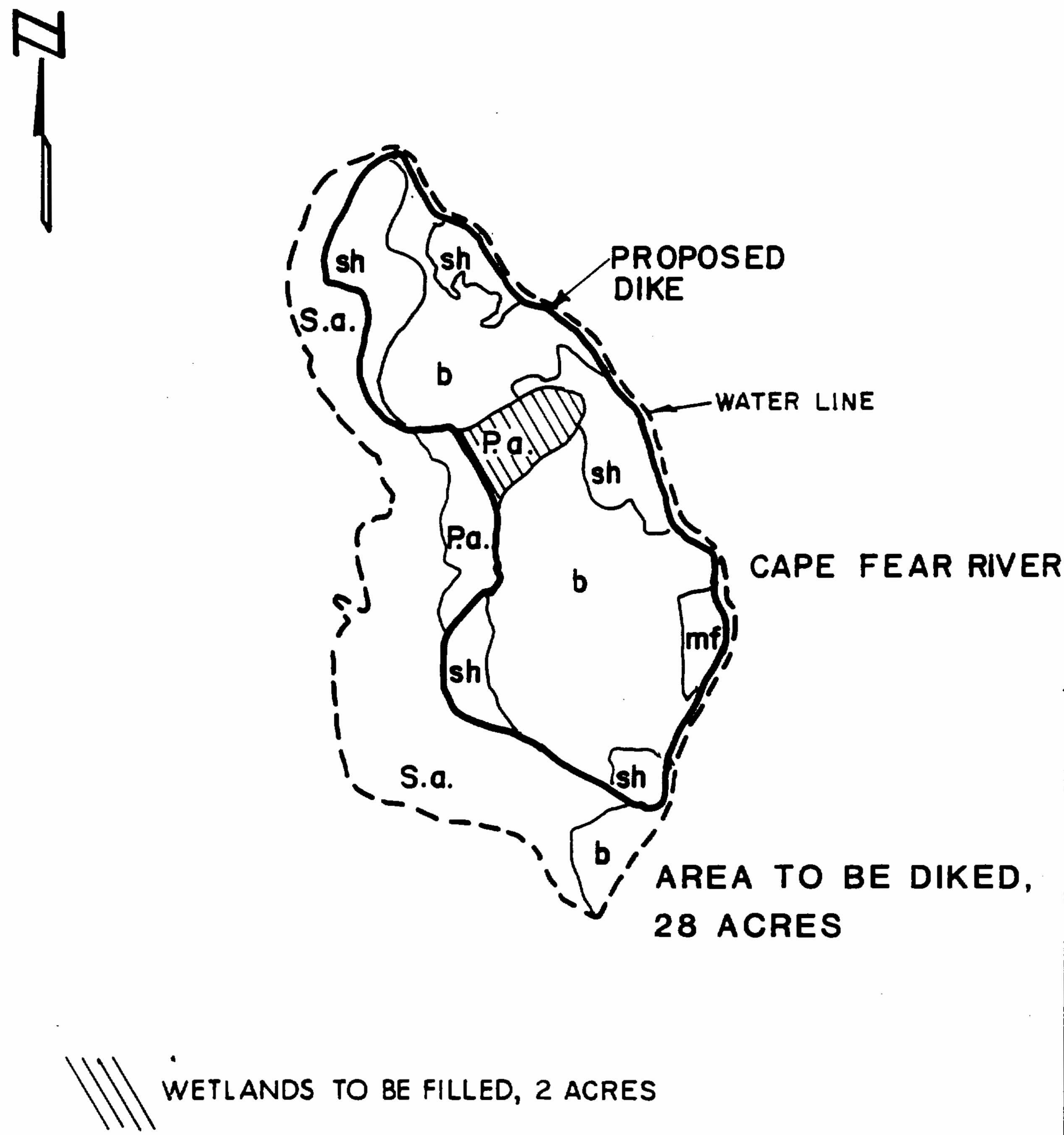
b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 10
VEGETATION MAP
FIGURE 11

0 250 500
SCALE IN FEET



SEE FIGURE 1 FOR LOCATION

LEGEND

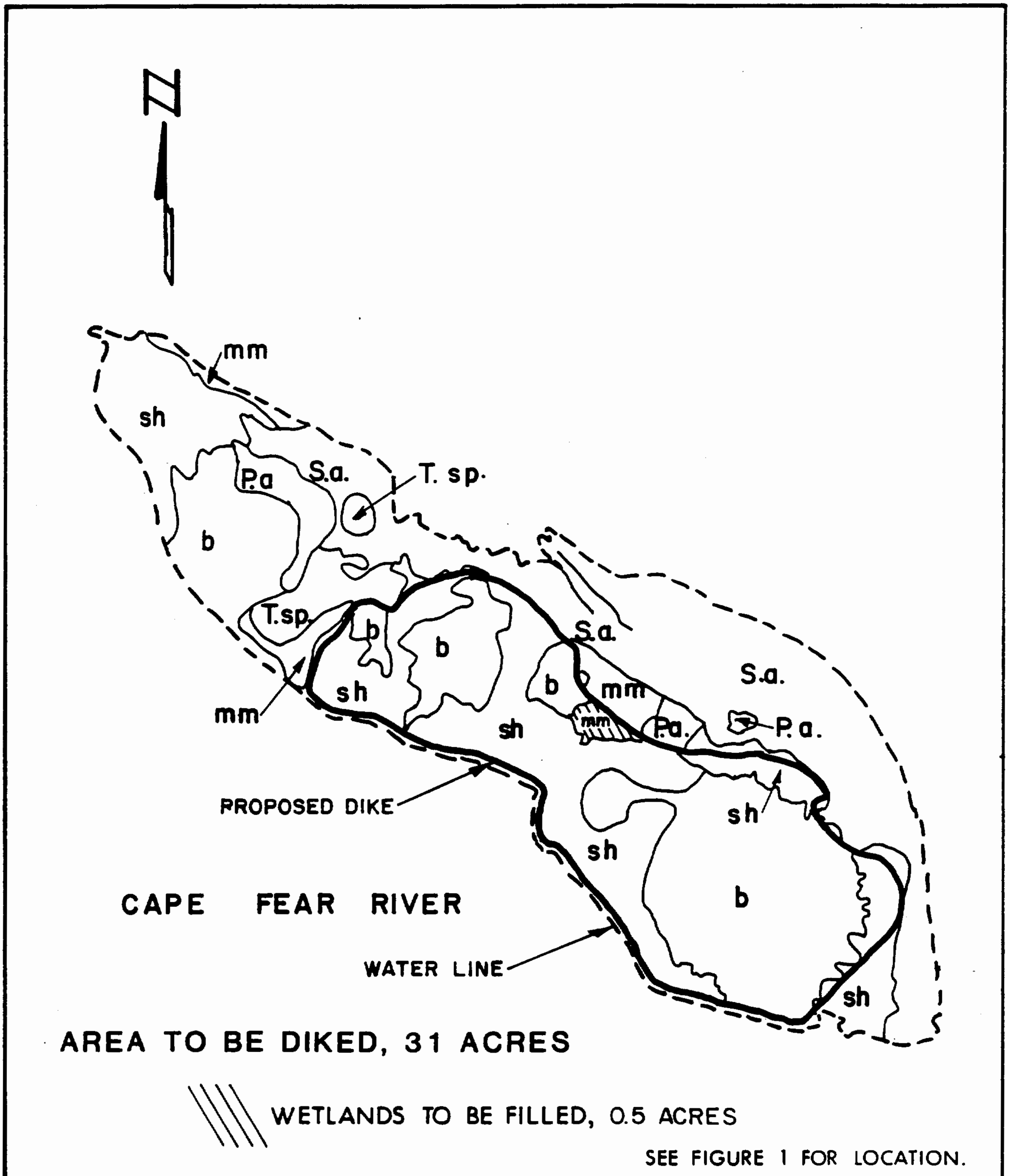
b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 11
VEGETATION MAP
FIGURE 12

0 250 500
SCALE IN FEET



LEGEND

b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

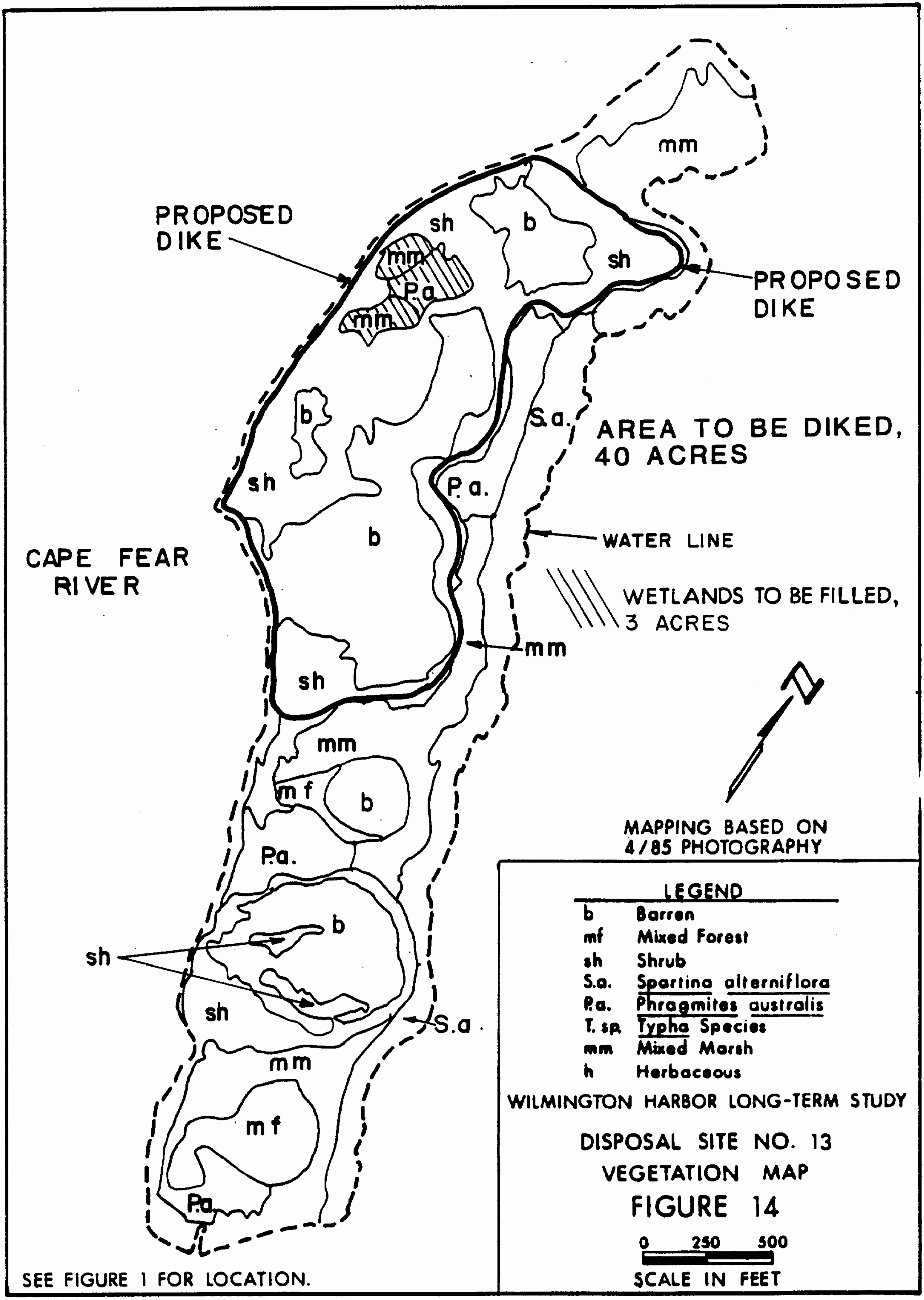
MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 12
VEGETATION MAP

FIGURE 13

0 250 500
SCALE IN FEET



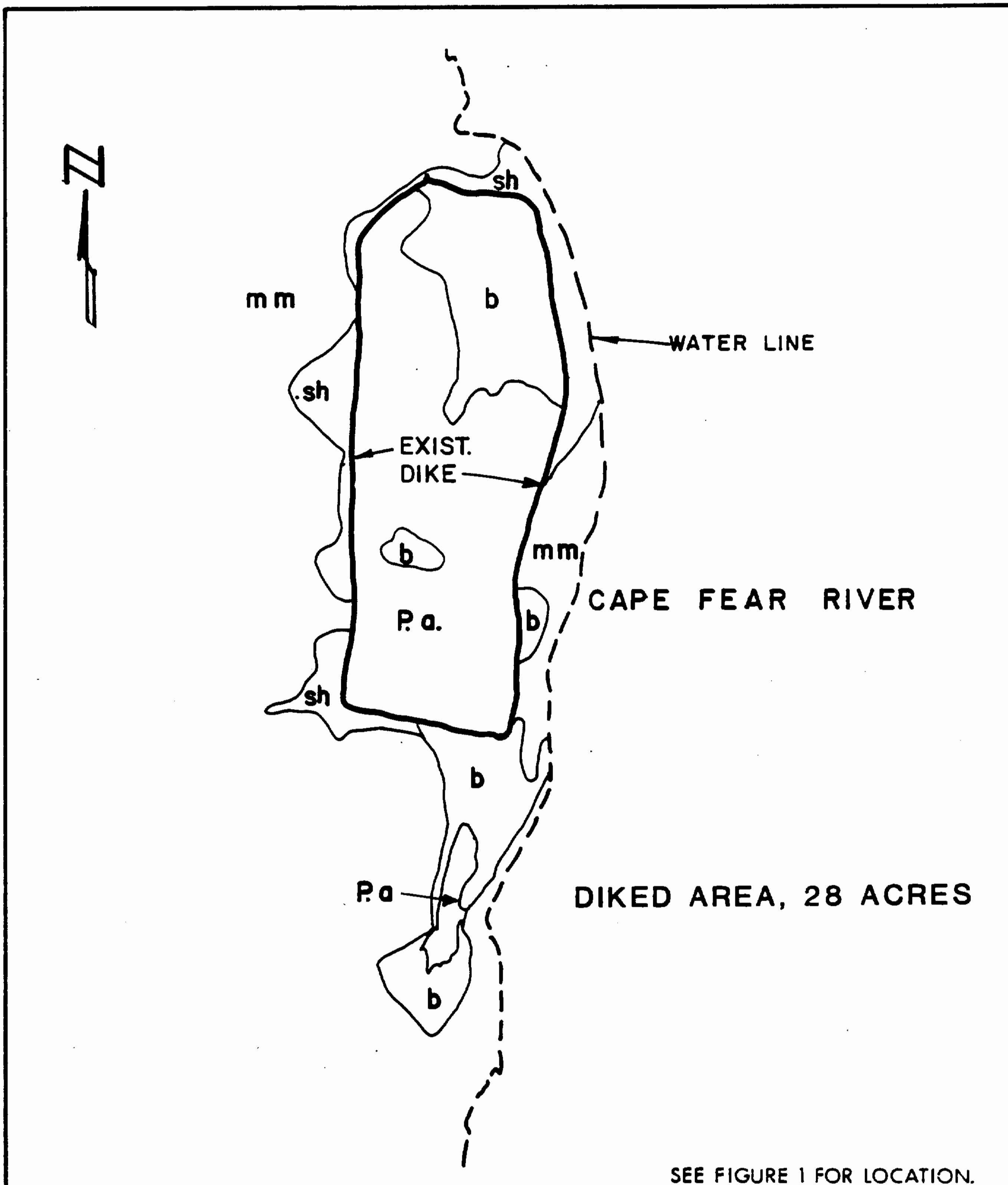
WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 13

VEGETATION MAP

FIGURE 14

SEE FIGURE 1 FOR LOCATION.



LEGEND

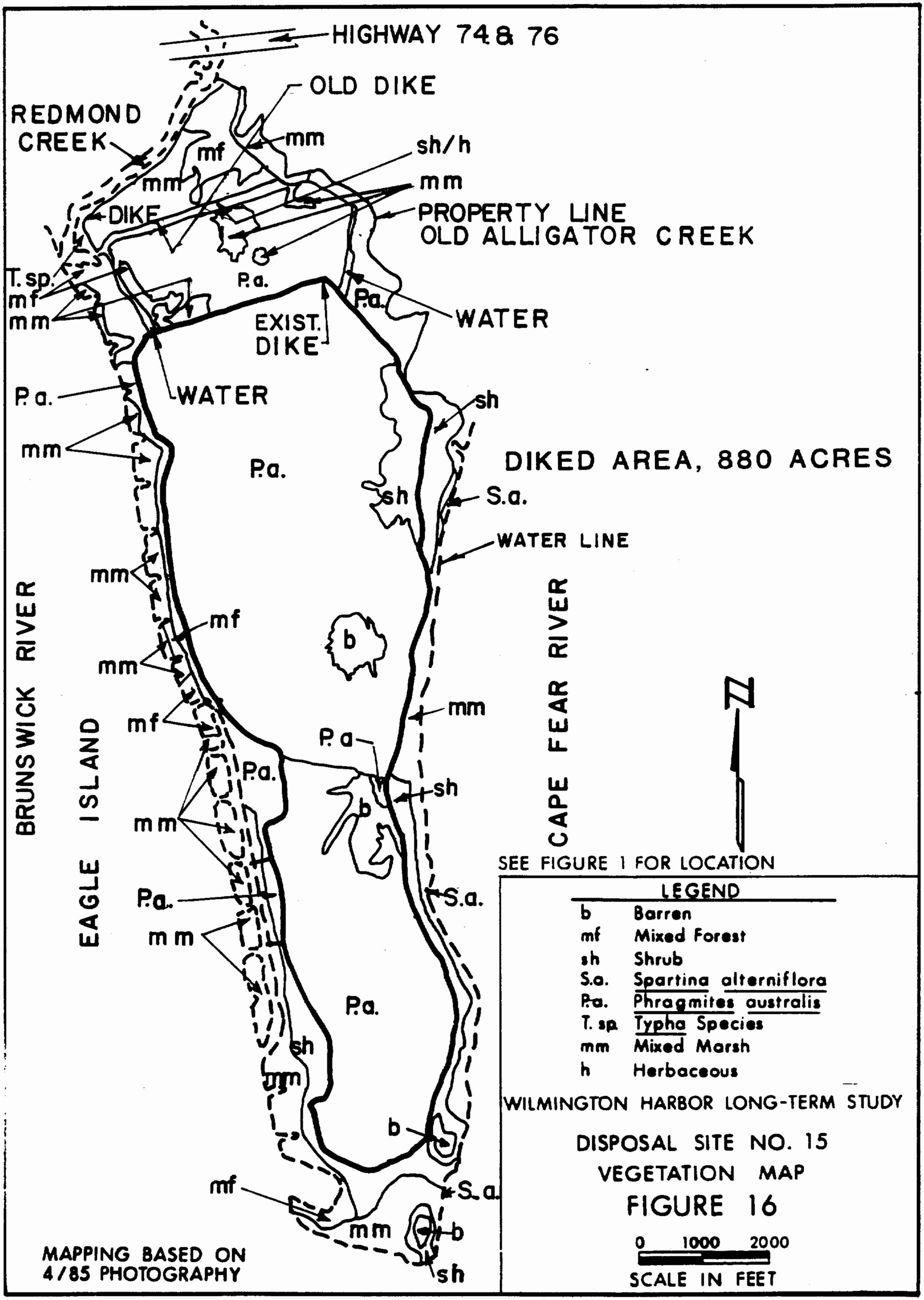
b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

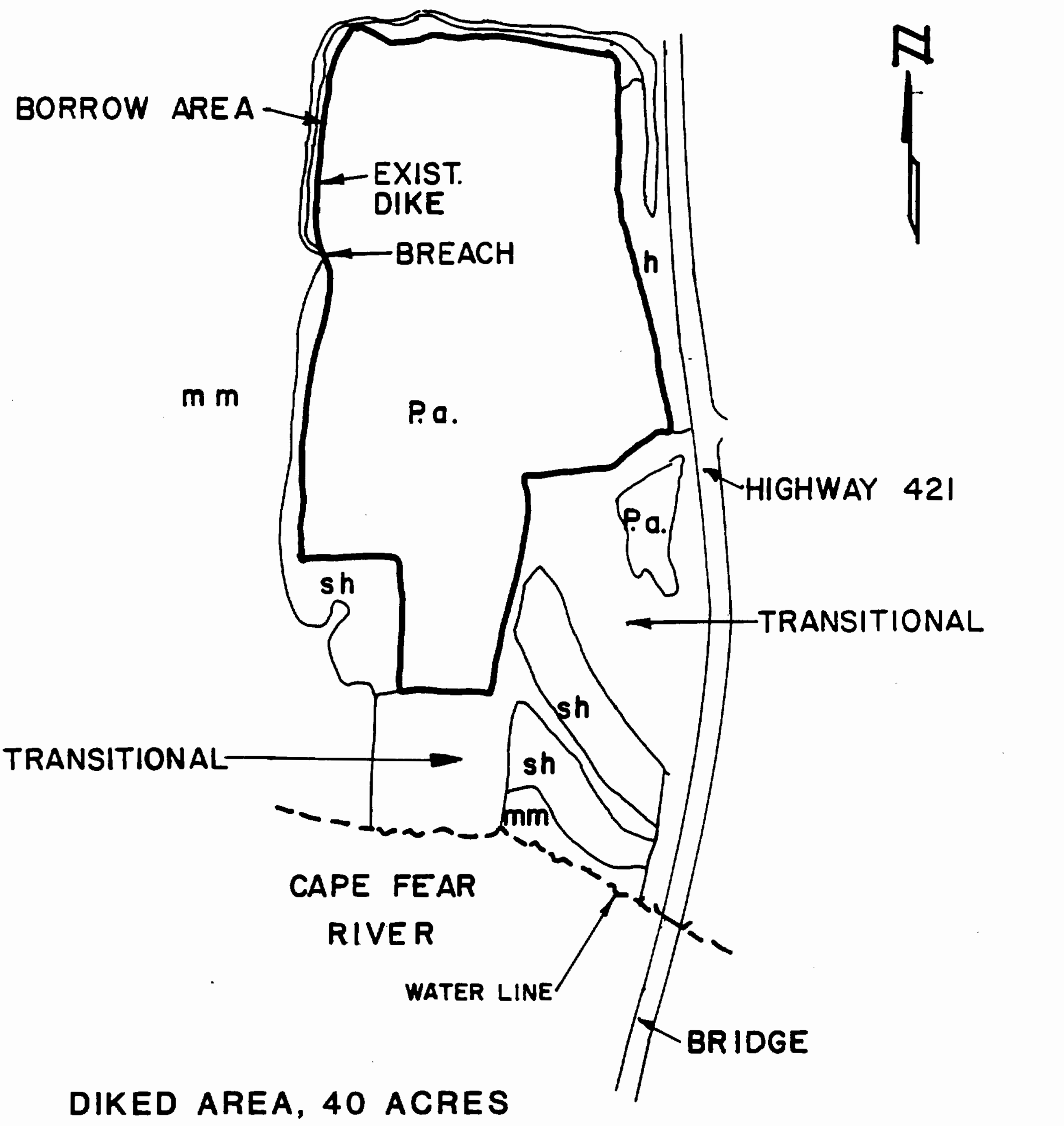
MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 14
VEGETATION MAP
FIGURE 15

0 250 500
SCALE IN FEET


HIGHWAY 74 & 76
OLD DIKE
REDMOND CREEK
mf
mm
sh/h
mm
DIKE
PROPERTY LINE
OLD ALLIGATOR CREEK
T. sp.
mf
mm
P.a.
EXIST. DIKE
WATER
P.a.
WATER
sh
DIKED AREA, 880 ACRES
P.a.
sh
S.a.
WATER LINE
mm
mf
b
BRUNSWICK RIVER
CAPE FEAR RIVER
EAGLE ISLAND
mm
mf
mm
P.a
P.a.
sh
b
m m
SEE FIGURE 1 FOR LOCATION
LEGEND
b Barren
mf Mixed Forest
sh Shrub
S.a. Spartina alterniflora
P.a. Phragmites australis
T. sp. Typha Species
mm Mixed Marsh
h Herbaceous
S.a.
P.a.
m m
P.a.
sh
mm
b
WILMINGTON HARBOR LONG-TERM STUDY
DISPOSAL SITE NO. 15
VEGETATION MAP
FIGURE 16
mf
S.a.
mm
b
0 1000 2000
SCALE IN FEET
MAPPING BASED ON 4/85 PHOTOGRAPHY
sh



LEGEND

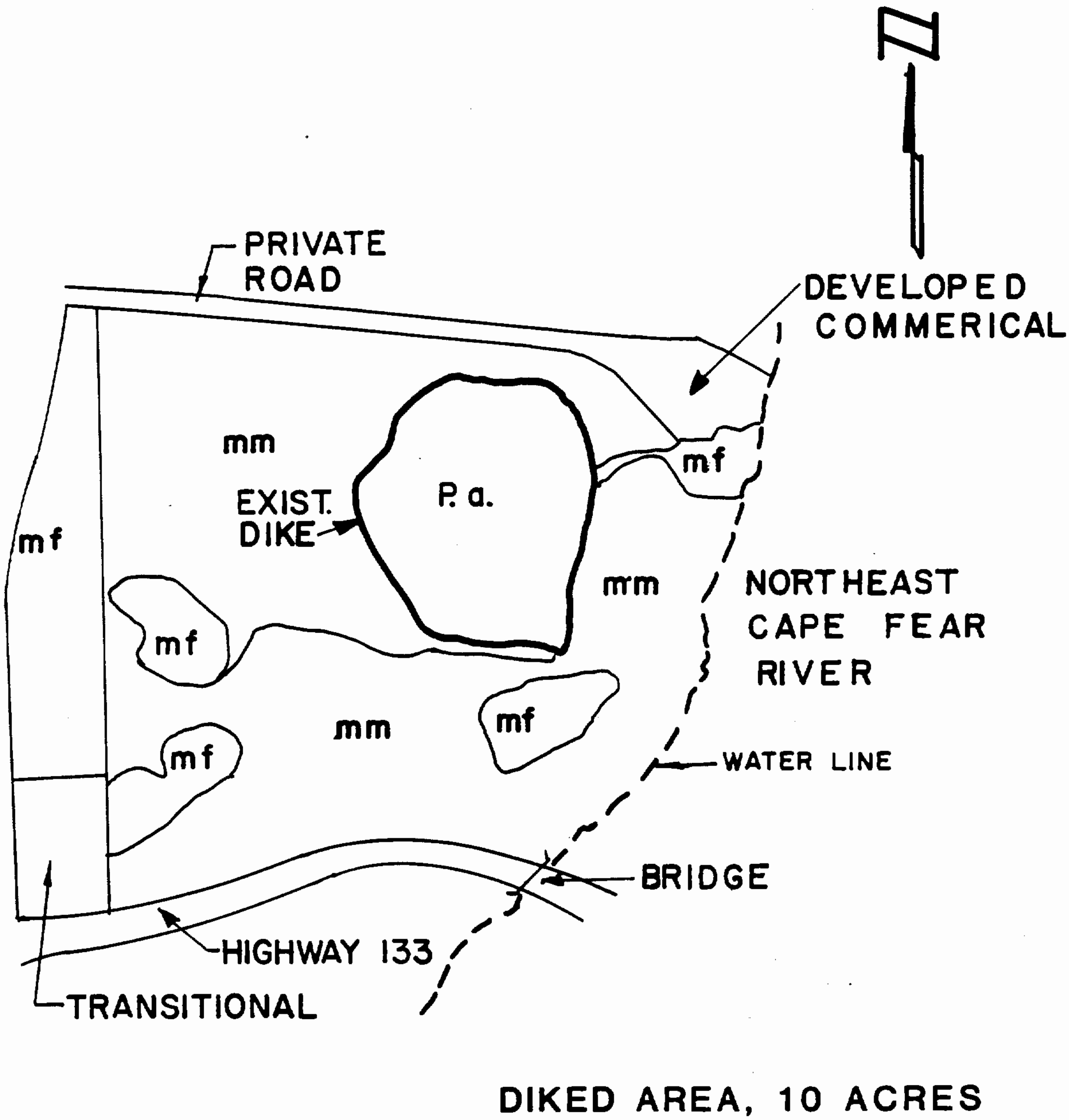
b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	Spartina alterniflora
P.a.	Phragmites australis and Salix nigra
T. sp.	Typha Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 16
VEGETATION MAP
FIGURE 17

0 250 500
SCALE IN FEET



SEE FIGURE 1 FOR LOCATION.

LEGEND

b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

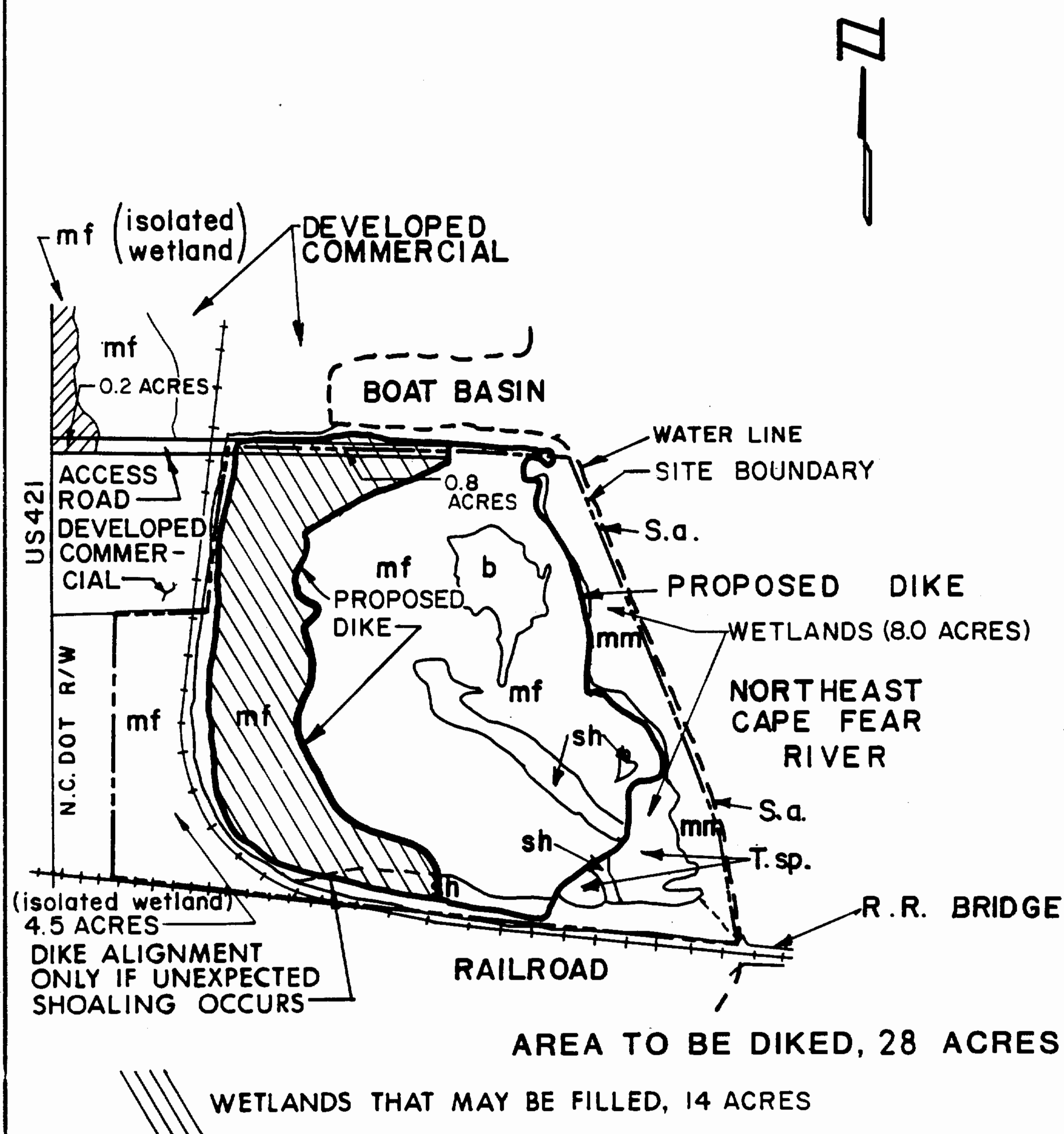
MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 17
VEGETATION MAP

FIGURE 18

0 250 500
SCALE IN FEET



SEE FIGURE 1 FOR LOCATION.

LEGEND

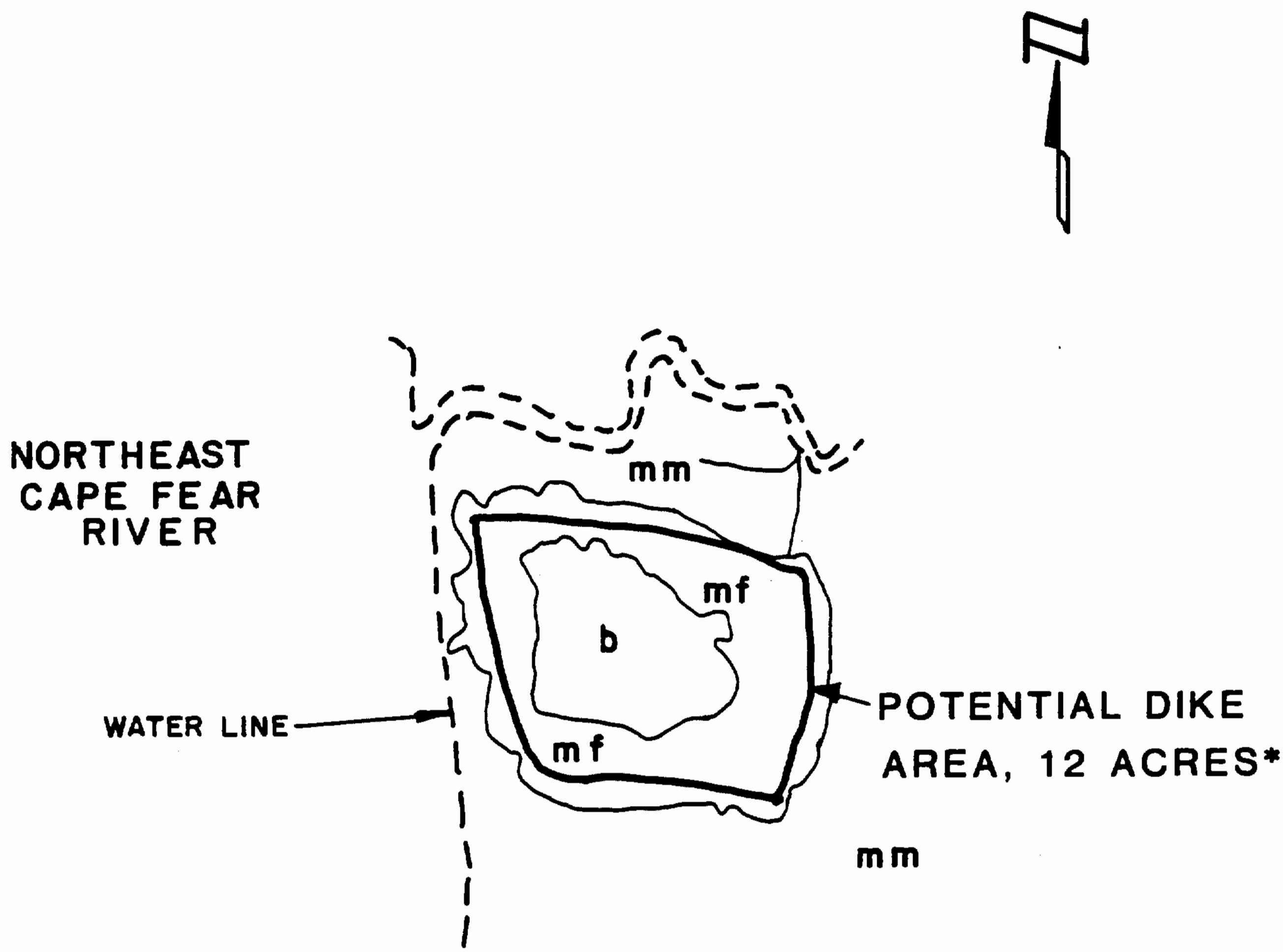
b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON 4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 18
VEGETATION MAP
FIGURE 19

0 250 500
SCALE IN FEET



* IF SITE 19 WAS PROPOSED FOR USE, THE DIKE ALIGNMENT WOULD BE AS INDICATED.

SEE FIGURE 1 FOR LOCATION.

LEGEND

b	Barren
mf	Mixed Forest
sh	Shrub
S.a.	*Spartina alterniflora*
P.a.	*Phragmites australis*
T. sp.	*Typha* Species
mm	Mixed Marsh
h	Herbaceous

MAPPING BASED ON
4/85 PHOTOGRAPHY

WILMINGTON HARBOR LONG-TERM STUDY

DISPOSAL SITE NO. 19
VEGETATION MAP
FIGURE 20

0 250 500
SCALE IN FEET

TABLE 7

Acreages of Habitat Types Within the Diked Portion of Each Disposal Site

	Disposal Site																	
Community Type	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total	%Total
Barren (b)	29	25	3			47	5	7	17	15	18	7	37			1	5	216	16.4
Mixed Forest (mf)									1							38	7	46	3.5
Shrub (sh)			2		2				8	16	19		29			3		79	6.0
Phragmites australis (P.a.)			41	9	7			29	2		2	21	810	40	10			971	73.7
Mixed Marsh (mm)										0.5	1							1.5	0.1
Herbaceous (h)							4											4	0.3
Total	29	25	46	9	9	47	9	36	28	31.5	40	28	876	40	10	42*	12	1317.5	100.0

* Site 18 contains at total of 54.5 acres, 42 acres of which have a potential of being located within the diked disposal area.

MIXED MARSH (mm) - These are marshes which have no clear dominant species and occur in tidal and non-tidal areas. Common species present in these areas include: Giant cordgrass (Spartina cynosuroides), pickerelweed (Pontederia cordata), saltmarsh bulrush (Scirpus robustus), American bulrush (Scirpus americanus), narrowleaf cattail (Typha angustifolia), common cattail (Typha latifolia), rose mallow (Hibiscus moscheutos), coastal arrowhead (Sagittaria falcata), sedge (Cyperus spp.), alligator-weed (Alternanthera philoxeroides), black needlerush (Juncus roemerianus), and spike-rush (Eleocharis sp.).

HERBACEOUS (h) - These communities are dominated by various grasses and forbs. They are located at higher elevations than the surrounding marshes and are not considered to be wetlands.

TRANSITIONAL AREA - This is an area that has been cleared of natural vegetation and where commercial activity is planned or low density commercial activity exists.

The most diverse terrestrial habitat was at site 18. Approximately 28 acres of the 42 acre site are uplands (mostly mixed forest) and 14 acres wooded wetlands (mixed forest). Some remnant dikes are located on the upland portion of the site. The 28 acres of upland contain several sandy dredged material domes (barren) that grade to the south and southwest through the upland mixed forest to the 14 acres of mixed forested wetlands (see section 4.2.3 for a description) adjacent to the railroad (figure 19). The upland forest near the domes has an overstory of sweet gum (Liquidambar styraciflua), red maple (Acer rubrum), loblolly pine (Pinus taeda), willow oak (Quercus phellos), black cherry (Prunus serotina) and common cottonwood (Populus deltoides). The understory has virginia creeper (Parthenocissus quinquefolia), trumpet creeper (Campsis radicans), poison ivy (Rhus radicans), Japanese honey suckle (Lonicera japonica), green briar (Smilax sp.) and grape (Vitus sp.).

4.2.2.2 Fauna. Wildlife populations of most of the dredged material disposal island sites are rather limited. Most of these islands are of recent origin and, due to their isolation from the mainland and repeated disturbance, have not had time to attract and establish stable wildlife communities. Previously undiked islands have better developed wildlife communities due to a lack of habitat disturbance since the late 1960's. Portions of islands 11, 12 & 13 are forested and the vertical stratification provided by the vegetation permits occupation by bird species not normally associated with the dredged material disposal islands in the river. Island 12, in particular, has well developed avian and mammalian communities. This is due to the presence of a wide variety of habitat types, relative habitat stability (it has not been disposed on since the late 1960's), and close proximity to the Cape Fear peninsula. Proximity to the peninsula has permitted the immigration of the many species of mammals which now occupy available habitat. During a field investigation of this island, signs of deer (Odocoileus virginianus), oppossum (Didelphis marsupialis), raccoon (Procyon lotor), marsh rabbit (Sylvilagus aquaticus, rice rat (Oryzymys palustris), and hispid cotton rat (Sigmodon hispidus) were seen. Other more secretive species such as shrews and cotton mice are probably also present.

Diked islands which are frequently disposed upon have depauperate species diversities due to the monoculture habitats present and the habitat disturbance caused by dredged material deposition. Such islands are not used to any appreciable extent by colonially nesting waterbirds and small mammal populations are restricted to species like marsh rabbit (*Sylvilagus aquaticus*), and rice rat (*Oryzymys palustris*).

Eagle Island is the largest disposal site which will be used during the future maintenance of the project and consists of a large complex of habitats. Much of the island is a large *Phragmites* monoculture of marginal wildlife habitat value. There are portions of the island which contain trees; however, and these areas provide denning and nesting areas for many species including raccoon and oppossum. Marsh rabbits, hispid cotton rats and rice rats are probably the most common species of mammals on the island. The presence of the long, linear borrow pits adjacent to the dike provides freshwater throughout most of the year. These borrow pits are heavily used by alligators, waterfowl and migrating shorebirds.

Site 18 is the most floristically diverse of all of the disposal sites being considered for use in the long-term maintenance of the project (section 4.2.2.1). Many soft and hard mast producing trees occur on the site as do shrub thickets, bare ground, and seasonal pools of water. Due to the diversity of habitat types found on the site, it supports a diverse population of song birds, small mammals and reptiles and amphibians (in ephemeral pools). While the habitat structure of the site is good, little evidence of actual use by deer or medium-sized mammals (e.g. raccoon) was noted during field investigations. This probably relates to the relatively small size of the site and the fact that it is isolated from adjacent woodlands by industries on the north and south and a four-lane highway (US 421) to the west.

Bird Nesting Sites. Several areas in the lower Cape Fear River region are used by colonially nesting waterbirds as nesting areas. Battery Island, a natural island which has received some dredged material in the past, is home to the largest colony of white ibises in North Carolina and is also used for nesting by other herons, egrets, and some ground nesting birds. Two man-made islands, the Old Royal Tern Island and the Ferry Slip Island (figure 1), were created by dredged material in the early 70's and are the most heavily used islands in the southeastern part of the state by ground nesting waterbirds.

The Wilmington District has supported efforts to manage waterbird nesting sites in the lower Cape Fear River in the past and will continue this practice in the future (USACE 1982). Management of nesting sites will be by deposition of dredged material on an as needed basis only for the purposes of erosion control and/or habitat management. All such depositions will be coordinated with appropriate interests prior to disposal. Management of Battery Island with dredged material will probably not be necessary and such action is not currently envisioned. If such a need was to arise; however, the District would respond if possible.

Deposition of dredged material on nesting areas will take place during non-nesting periods if possible. Preferred timing for disposal would, therefore, be between 1 August and 15 March.

4.2.3 Wetlands and Floodplains.

Wetlands involved with the maintenance plans are located within or nearby existing or proposed diked disposal areas. These disposal areas are designated 11, 12, 13, 15, 16 and 18 (figure 1). Sites 11, 12, and 13 are not diked, 16 and 18 have remnant dikes and 15 has maintained dikes.

All of the wetlands discussed below fall under Section 404 of the Clean Water Act of 1977, as amended. In addition, all wetlands except the wooded wetlands and common reed areas fall under the State of North Carolina Coastal Area Management Program as Areas of Environmental Concern. Sites 15 and 16 have received, under previous actions, all appropriate environmental clearances under these regulations for the disposal of dredged material.

At site 11, the wetlands consist of a finger of intertidal common reed (*P. australis*) on the west side of the island (figure 12). This wetland is approximately 2.0 acres and contains a 200 square feet patch of black needlerush (*Juncus roemerianus*). Fiddler crab (*Uca* sp.) burrows were located throughout this marsh finger. This area has saturated soils and is covered by tidal waters several times per month.

Site 12 has a 0.5 acre patch of wetland along the west side to be incorporated into the dike alignment (figure 13). The patch is approximately 80% black needlerush and 20% giant cordgrass (*Spartina cynosuroides*) with fiddler crab burrows scattered throughout. This area has saturated soils and is covered by tidal waters several times per month.

Site 13 contains a 3.0 acre patch of wetland in the northwest corner (figure 14). The wetland is located behind a berm and is probably flooded only a few times each year. The dominant species is common reed (2.0 acres) with saw grass (*Cladium jamaicense*), and giant cordgrass present. The soils are saturated intermittently due to infrequent flooding and have fiddler crab burrows present.

In addition, along the shoreline of sites 11, 12, and 13, a total of 0.5 acre of intertidal marsh (saltmarsh cordgrass) and 0.8 acre of high marsh are present. The high marsh consists of a mixture of black needlerush, saltmeadow hay (*Spartina patens*), giant cordgrass, glasswort (*Salicornia* spp.), sea lavender (*Limonium carolinianum*), sawgrass and common reed. Most of this existing marsh is being lost to ongoing erosion.

Site 15 is the Corps of Engineers Eagle Island diked disposal area (figure 16). The portion to be used for disposal of dredged material is approximately 880 acres and is dominated by common reed.

The 40 acre site 16 disposal area is dominated by common reed and black willow (*Salix nigra*)(figure 17). The dike surrounding this area is intact except on the west side which has one major breach. The area around this breach is probably flooded several times a month by tidal waters.

Of the 54.5 acres at site 18, the site contains 26.5 acres of wetlands, of which 14 acres are wooded wetlands that may be incorporated within the diked disposal area (section 3.2.2, figure 19). These wooded wetlands are located between the upland portion of the site and the railroad. The wooded wetlands are dominated by red maple (Acer rubrum) with common cottonwood (Populus deltoides), tulip poplar (Liriodendron tulipifera), and sweet gum (Liquidambar styraciflua) and have an understory of tear thumb (Polygonum arifolium), lizard's tail (Saururus cernuus), mulberry (Morus rubra), privet (Ligustrum sinense), Japanese honey suckle (Lonicera japonica) and poison ivy (Rhus radicans). The wooded wetlands may be flooded a few times a year by spring high tides, but the principal source of inundation appears to be from rainfall.

Site 18 also contains 8.0 acres of wetlands located between the Northeast Cape Fear River and the upland portion of the site. These wetlands are dominated by mixed marsh containing cattails (Typha latifolia and angustifolia), and giant cordgrass (Spartina cynosuroides). Within this mixed marsh are scattered patches of shrub thickets containing grounsel tree (Baccharis halimifolia), wax myrtle (Myrica cerifera), Japanese honey suckle and red maple with an occasional bald cypress (Taxodium deltoides) (30-40 feet tall). Adjacent and parallel to the river is a 15-20 foot wide berm approximately one foot above mean high water. This berm is dominated by the shrub thicket species indicated above with the bald cypress becoming more frequent toward the northern end of the property. The 8.0 acre wetland area is flooded several times per month by a combination of high tides and high river flows.

Located in the southwest corner of the site is 4.5 acres of isolated wooded wetlands. This wetland is dominated by an overstory of red maple, black willow and an occasional black gum (Nyssa sylvatica) with an understory of Japonese honeysucle, lizard's tail, poison ivy and chain fern (Woodwardia areolata). Ephemeral pools are located throughout. The wetland is isolated by the railroad track on the south and east and by the North Carolina Department of Transportation right-or-way and commercial development on the west and north, respectively. The saturated soils are due to rainfall and a high groundwater table.

In the northwest corner of the site, a permanent 60' wide access road may be constructed that would cross 0.2 acres of isolated wooded wetlands adjacent to heavily traveled US Highway 421 (figure 19). This wetland contains an overstory of red maple, black willow, and sweetgum with an understory of lizard's tail and blueberry (Vaccinium sp.). This wetland is isolated by US Highway 421 on the west and upland mixed forest or commercial development on the other sides. As with the 4.5 acre isolated wetland discussed in the previous paragraph, the saturated soils are due to rainfall and a high groundwater table.

These existing disposal sites are located within the 100 year floodplain.

4.3 Threatened and Endangered Wildlife, Plants. On 14 April 1986, a letter was sent to the U. S. Fish and Wildlife Service (Asheville Endangered Species Field Station) and the National Marine Fisheries Service (Southeast Regional Office) requesting lists of threatened or endangered species which should be considered in the development and documentation of the long-term maintenance plan for the project. The U.S. Fish and Wildlife Service's list of species to be considered was amended by telephone on November 30, 1987 due to additions and deletions from the list which had occurred since the previous coordination. The lists provided by these agencies were combined to develop a composite list which was used during plan formulation. This list is as follows:

MAMMALS

West Indian manatee (*Trichechus manatus*)
Finback whale (*Balaenoptera physalus*)
Humpback whale (*Megaptera novaeangliae*)
Right whale (*Eubaleana glacialis*)
Sei whale (*Balaenoptera borealis*)
Sperm whale (*Physeter catadon*)

BIRDS

Red-cockaded woodpecker (*Picoides borealis*)
Bald eagle (*Haliaeetus leucocephalus*)
Piping plover (*Charadrius melodus*)

REPTILES

Loggerhead sea turtle (*Caretta caretta*)
Kemp's ridley sea turtle (*Lepidochelys kempii*)
Green sea turtle (*Chelonia mydas*)
Hawksbill sea turtle (*Eretmochelys imbricata*)
Leatherback sea turtle (*Dermochelys coriacea*)

FISH

Shortnose sturgeon (*Acipenser brevirostrum*)

PLANTS

Rough-**leaved** loosestrife (*Lysimachia asperulaefolia*)

See section 5.3 regarding the results of the consultation process on these species.

4.4 Areas of Archaeological and Historical Significance. The lower Cape Fear River region is rich in cultural resources with many sites listed on the National Register of Historic Places. National Register sites occurring in the immediate vicinity of the Wilmington Harbor project include the following:

Ft. Fisher National Historic Landmark

Brunswick Town and the wreck FORTUNA
Fort Anderson
Lighthouse District
Fort Caswell
Fort Johnston
Historic Wilmington Waterfront
Shipwreck of the CSS RALEIGH

Other sites which are believed eligible for the National Register but not yet listed include: Prices Light, Battery Lamb, Robbins House, historic archeological site 31NH95 and prehistoric site 31NH507.

Because the harbor project has been in place for many years and navigation of the river has long been an important part of the regions history, it's continued maintenance is considered to be compatible with the objective of preserving the region's historical character and attributes. All disposal sites have been disposed on during previous maintenance events.

4.5 Socioeconomic Considerations Related to Wilmington Harbor.

4.5.1 Land Use. In accordance with the North Carolina Coastal Area Management Act, New Hanover and Brunswick Counties have developed land use plans. According to the most recent updates (1987 Brunswick County and 1986 New Hanover County), the dredged material disposal areas fall in one of two classifications: transition or conservation. The "transition" classification provides for future intensive urban development within the ensuing ten years. The "conservation" classification provides for effective long-term management of significantly limited or irreplaceable areas. **These areas include wetlands, unique shoreline areas and areas hazardous for development.**

4.5.2 Population. The Wilmington area, including New Hanover, Brunswick, and Pender counties, had a 1985 population of 181,500; an increase of 12.4 percent since 1980. While the state was growing about 1 per cent a year, the Wilmington area was growing at about 2 per cent per year. Brunswick County has been the second fastest growing county in the state over that five year period.

4.5.3 Income and Employment. The latest economic data available (1983) show that the state of North Carolina has about 1,960,000 employees and an annual payroll of about 29 billion dollars. Of those, about 780,000 work in manufacturing making about 13 billion dollars, and about 120,000 work in transportation and public utilities making about 2.5 billion dollars. The Wilmington area, including New Hanover and Brunswick counties, have about 45,000 employees making about 700 million dollars.

Personal Income. Research Triangle Institute (1983) indicates that salaries and benefits resulting from the public docks (i.e. the NC State Port Authority (NCSPA)) at Wilmington in 1982 were about $545,000,000. Adding the salaries and benefits from the public docks to the estimated impacts of salaries and benefits resulting from private docks yields a total estimate of about $909,000,000 for 58,747 workers (table 8), or $15,470 per worker. The per capita amount for the affected population of 135,120 was about $6,730.

Salaries and benefits generated for each 1,000 tons of cargo moved across Wilmington's docks in 1982 were about $152,500.

Employment. In the North Carolina economy, an estimated average of 9.9 jobs in 1982 resulted from each 1,000 tons of cargo moving through the entire harbor at Wilmington. The relationship for public docks (NCSPA) indicated that about 14.7 jobs resulted for each 1000 tons of cargo moved due to the higher value of the break bulk and containerized cargo handled at the NC State Port Docks. Cargo handled at private docks at Wilmington is primarily bulk materials and petroleum products, which has lower values and creates less jobs. The situation is essentially reversed at Morehead City where the majority of cargo handled by the NCSPA is bulk materials and petroleum products, similar to those handled at the private terminals in Wilmington. About 6.6 jobs resulted from each 1,000 tons of cargo moved at Morehead City. Therefore, the 6.6 figure was used for private activities at Wilmington for estimating purposes. As shown in table 8, the estimated total full-time equivalent jobs throughout North Carolina attributed to the harbor at Wilmington was about 58,747 in 1982.

An indication of the number of people affected by the ports may be determined by using population-to-worker ratios. The 1980 ratio of 2.3 to 1 for the State was used because of the widespread effects of the ports. Based on employment resulting from activities in Wilmington Harbor of about 58,747 in 1982, an estimated 135,120 people in North Carolina received the economic benefits of employment because of the operation of that port (table 8). The number of persons affected per 1,000 tons of cargo moved was about 23.

4.5.4 Existing Terminal Facilities. Forty-three principal wharves, piers, and docks are located at the port of Wilmington, with berthing space of about 20,000 linear feet to serve the harbor. These facilities handle containers, general cargo, chemicals (including fertilizers), and petroleum products. Specialized cargo handled through local facilities includes asphalt, gypsum, molasses, cement, tobacco, wood pulp, and salt.

Major capital investment has been made at the NC State Ports since the early 1970's. Total investment from 1977 to 1984 amounted to approximately $21 million, of which $12.5 million was container related.

The NCSPA has **approved and the Legislature has funded** a Master Development Plan for the ports of Wilmington and Morehead City, covering the period from 1986 to 1990. They propose capital expenditures of $36 million for the port of Wilmington, including a new 900-foot container berth costing about $14 million and two additional container cranes at $3.5 million each. Additional items include the rehabilitation of several berths, wharf repairs, and increased storage areas and heavy equipment. This plan includes major maintenance of facilities, some of which are nearly 50 years old, and improvements to service larger container ships of the Panamax class. **The new container berth is under construction and expected to be fully operating in 1990.**

TABLE 8

PORT OF WILMINGTON BENEFITS - 1982
WILMINGTON HARBOR

	Public Docks	Private Docks	Total
Employment*	35,207	23,540	58,747
Salaries & Benefits	$544,766,000	$364,240,000	$909,006,000
State and Local Taxes**	$70,391,000	$47,065,000	$117,456,000
Affected Population	80,980	54,140	135,120

*Full-Time Equivalent

**Based on Fiscal Year 1982 (July 1 - June 30) taxes and calendar year tonnages.

4.5.5 Waterborne Commerce. A comparative statement of commodity traffic for Wilmington Harbor for the 35-year inclusive period 1952-1986 is shown in table 9. These data are taken from the Corps of Engineers publication Watérborne Commerce of the United States.

During the entire period, total tonnage increased 68.2 percent, for an annual compound growth rate of approximately 1.5 percent. Better rates of growth have occurred during the 10-year period of record (1969-1979), which resulted in a total gain of 107 percent, or an average annual compound growth rate of approximately 7.6 percent. Since 1979, total tonnages have generally dropped, due primarily to significant reductions in petroleum products and metallic ore traffic. Approximately 85 percent of the total commodity tonnage carried in recent years include the categories of (1) petroleum products; (2) chemicals and allied products; (3) non-metallic minerals; (4) fabricated metal products, except fuels; and (5) pulp, paper, and allied products (table 10). The largest tonnage of a single commodity handled in 1986 was paraxylene, classified as basic chemicals and products, which is used to produce polyester fiber. The largest group was petroleum products, which includes gasoline, fuel oil, asphalt and solvents. In 1986, a total of nearly 2.6 million tons of petroleum products were carried, or approximately 40 percent of the total.

Most of the passenger traffic indicated in table 9 is from the Ft. Fisher-Southport Ferry.

4.5.6 Financial Value of the Port. Studies by the Research Triangle Institute (RTI 1983) indicate that the benefits of Wilmington Harbor to the State's economy are substantial and reach well beyond the immediate vicinity of Wilmington. Estimated impacts for 1982 from RTI (1983) which addressed the impacts of the public port facilities of the NCSPA only, are shown in table 8 for Wilmington. Estimates are also shown for the impacts of private docks, based on tonnage relationships established for public docks.

Total commerce moved at Wilmington in 1983 was about 5,123,000 tons, 2,349,000 across public docks and 2,744,000 across private docks. This was the lowest total tonnage for the harbor since 1969.

Tax Revenues. State and local taxes generated by Wilmington Harbor for each 1,000 tons of cargo moved were estimated at about $19,700, using fiscal year 1982 tax data and calendar year tonnage. This resulted in a total of about $117,500,000 for calendar year tonnage. State income taxes and sales taxes (including gasoline) each accounted for about 35 percent, and local property taxes accounted for about 30 percent.

Industrial Development. North Carolina's harbors result in firms and industries that are required, attracted, or induced by port activities. These categories accounted for about 5, 3, and 92 percent, respectively, of employment resulting from the harbor at Wilmington in 1982. Required industries include those which provide transportation and other services that are necessary to support harbor operations. The second category includes those firms that export commodities and those that import products for assembly or distribution within the United States that are attracted to North

TABLE 9

WILMINGTON HARBOR N.C.
WATERBORNE COMMERCE
COMPARATIVE STATEMENT OF TRAFFIC

Year	Tons	Passengers
1952	4,047,765	34
1953	4,109,141	67
1954	4,092,862	192
1955	4,693,306	1,171
1956	4,777,127	886
1957	4,752,777	11,727
1958	4,826,608	3,502
1959	5,137,905	5,565
1960	5,168,062	960
1961	4,796,498	713
1962	5,590,064	3,436
1963	6,276,443	1,039
1964	5,545,743	14,661
1965	4,742,108	528
1966	5,272,182	51,472
1967	4,928,333	68,913
1968	5,001,228	103,720
1969	4,971,033	77,403
1970	6,316,740	75,986
1971	6,826,751	86,120
1972	8,535,227	89,001
1973	10,061,882	97,883
1974	9,383,342	100,543
1975	7,939,207	116,891
1976	8,682,623	123,487
1977	10,000,290	104,432
1978	9,920,216	116,491
1979	10,293,376	145,403
1980	8,402,279	152,229
1981	8,434,798	129,739
1982	5,960,350	134,120
1983	5,123,292	145,311
1984	5,797,706	155,402
1985	**5,632,063**	**176,013**
1986	**6,806,915**	**228,324**

SOURCE: Waterborne Commerce of the United States, various years, U.S. Army Corps of Engineers.

TABLE 10

WILMINGTON HARBOR
OCEANGOING COMMERCE - 1984

Commodity Classification	Percentage of total
Petroleum Products	41.25
Chemicals and Allied Products	27.56
Non-metallic Minerals, except Fuels	8.36
Primary and Fabricated Metal Products	5.79
Pulp, Paper Products, and Printed Matter	5.47
Tobacco, leaf	2.30
Food and Kindred Products	2.08
Lumber and Wood Products, Furniture and Fixtures	1.67
Stone, clay, glass, and concrete products	1.21
Machinery and Transportation Equipment	1.01
Department of Defense and Special Category Items	0.71
Metallic Ores	0.70
Farm Products other than Tobacco, Leaf	0.53
Textiles and Apparel	0.49
Waste and Scrap Materials	0.39
Rubber and Plastic Products, Leather and Leather Prod.	0.14
Tobacco Products	0.13
Other	0.21
	100.00

SOURCE: Waterborne Commerce of the United States, 1984
U.S. Army Corps of Engineers.

Carolina because of the presence of the ports. Induced industries are those in the State which expand their markets by exporting through the State's ports. Indications of the types of industries affected in addition to those required for port operations are shown in table 10 as to the percent of total commerce moved through Wilmington in 1984.

4.5.7 Existing Transportation Links. The project area is served by modern air, rail, and major highway links. The New Hanover County Airport is served by one major airline, Piedmont, offering service through its connecting hubs throughout the country. A commuter airline affiliated with American Airlines has connecting service through its hub at Raleigh-Durham Airport. A new, modern airport terminal for New Hanover County is under construction and is scheduled for completion in the fall of 1990.

Rail service is provided by the Seaboard Coastline Railroad with one line connecting to the main line at Hamlet, N. C. Because of additional traffic and greater weights, due primarily to the transport of containers, tracks and other facilities at the port and around the city have been upgraded. Some of the rail lines leading out of the port in various directions have been abandoned, usually in the rural areas outside of Wilmington.

Four major U.S. Highways, namely, Highways 74-76, 421, 117, and 17 connect the area to the Interstate Highway System and to the major cities in North Carolina, South Carolina, and Virginia. Also, construction is underway on an extension of Interstate 40 from Raleigh to Wilmington. The portion of I-40 from Wilmington to Wallace is complete, with the remainder scheduled for completion by July, 1990. U. S. 74 is almost entirely a four-lane highway to Charlotte. Improvements to several highways, including a by-pass of Bolton on U.S. Highway 74, are under construction and others are included in the State's transportation plan. Also the city of Wilmington has begun land acquisition for the Smith Creek Parkway, connecting the Interstate 40 terminus with downtown Wilmington and the port area. Smith Creek Parkway, as envisioned, would route traffic from I-40 to downtown, across the Northeast Cape Fear River (CFR) Bridge (N.C. 133), the new CFR Bridge, and back across the river via the CFR Memorial Bridge to the port. The city has passed a transportation bond issue to speed construction of additional connector streets and highways.

4.5.8 Recreational Boating Traffic. Wilmington Harbor has a large amount of recreational boating traffic in the area below Snow's Cut and a much smaller amount above there. The Atlantic Intracoastal Waterway follows the Cape Fear River channel from Fort Caswell up to Snow's Cut. It carries a large amount of transient recreational boating, as well as local recreation in the vicinity of Southport. On calm summer days the area from Southport to the mouth of the river near Bald Head Island is heavily used by all types of recreational boating.

In the area between Snow's Cut and the upstream limit of the harbor, there is only a small amount of recreational boating. The city of Wilmington completed a municipal dock in conjunction with Riverfront Park in 1982 and a boat ramp at the foot of Castle Street in 1986. A southern extension of the municipal dock and other improvements were completed in 1988. There is also a proposal to extend the Riverfront Park northward to a convention center at the

CSX Railroad property. These changes have increased recreational boating along the Wilmington waterfront, but at present large usage has only occurred during special events (Riverfest and the Azalea Festival). Recreational boating will certainly increase in all reaches of the harbor during the next fifty years as more facilities are developed.

4.5.9 Esthetics. The lower Cape Fear River region is very scenic, with many miles of ocean beach, historic homes and lighthouses, and large expanses of salt marsh bordering the river. The majority of the dredged material disposal sites occur within the river and are visible only from a boat or from the adjacent shore of the river. Site 18 is totally hidden from view and cannot be seen from the river or from any road.

5.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED PLAN

5.1 Significant Resources.

5.1.1 Geology and Mineral Resources. The proposed action will not significantly impact geology or mineral resources.

5.1.2 Seismology. The Wilmington Harbor area is relatively aseismic. The proposed action will not be affected by seismic activity.

5.1.3 Sediments and Grain Size Analysis. Since the project involves only maintenance, the grain size and sediment characteristics of the reaches to be dredged will not be changed and the associated disposal area grain size will remain relatively the same.

5.1.4 Water Resources.

5.1.4.1 Groundwater. Disposal of dredged material into the upland diked disposal areas 15, 16 and 18 and islands (3,4, and 6-13) will not adversely impact the groundwater quality. Groundwater gradients are into the river and dredged materials from the river have chloride contents equal to or less than that of the river in the vicinity in which they are disposed.

5.1.4.2 Surface Water Quality. Effluent from the spillways of diked upland disposal areas will not significantly impact water quality. The discharge of effluent from diked upland disposal areas is covered under Section 401 (P.L. 95-217) Water Quality Certification No. 1273 issued November 10, 1978 and a Nationwide Section 404 permit (33 CFR 330.5(a)(16)).

The water quality impacts resulting from the disposal of dredged material within the Wilmington Harbor ODMDS were discussed in USEPA's final environmental impact statement for designation of the ODMDS (USEPA 1983). According to that document, the disposal of dredged material at the Wilmington Harbor ODMDS should not significantly degrade water quality in regions adjacent to the disposal site. Water quality impacts will include minimal and short-term suspended solids plumes and releases of soluble trace constituents.

The water quality impacts associated with the resuspension of sediment particles into the water column during a dredging operation are short-term but unavoidable. A result of the resuspension is an increase in the suspended solids (non-filterable residue expressed as mg/l) concentration in the water column. The concentrations of suspended solids do affect turbidity, an optical property of water often measured as NTUs (nephelometric turbidity units); however, the two terms are not synonymous.

The plume, the area where the dredge induced suspended solids concentrations are discernibly increased relative to background levels, is dependent on many factors including, currents, winds, salinity, sediment type, and the type of dredge used.

The characteristics of sediment resuspension associated with hydraulic pipeline, hopper, and clamshell dredges are summarized in the following discussion adapted from Raymond (1984), Barnard (1978), and Hayes et al. (1984):

> Note: The sediment grain size in Wilmington Harbor is generally larger than that for the indicated three studies. Therefore, the sediment resuspension resulting from dredging most channels in Wilmington Harbor should be of shorter duration and lesser concentration and areal extent than that associated with the discussion below. Also overflowing of the decant water from the hopper dredge will continue in the ocean bar channels and overflow of decant water from the hopper or bucket and barge operation in the rest of the harbor is proposed where the sediments are predominantly sand. In areas that are predominantly sand (table 6), the overflow will tend to have minimal suspended solids and the barge loads will be more efficient.

For a hydraulic pipeline dredge, resuspended materials result from materials that are loosened by the cutterhead but not picked up by the suction. Suspended solids (increases above background) within 50 ft of the cutterhead have seldom been found to exceed 100 mg/l. Figure 21 illustrates the average suspended solids concentration associated with an 18 inch hydraulic pipeline dredge operation in fine-grained sediments in the James River of Virginia. Even though sediment resuspension with the hydraulic pipeline dredge has its source at the bottom, action of the cutterhead and the currents, especially the stronger ebb currents, can move the plume upward in the water column.

For a hopper dredge, resuspended sediment results from material loosened by the action of the draghead and not picked up by the dragarm suction, hopper overflow during loading, and turbulence generated by the vessel and its propwash. Generally, a well-defined surface plume is generated by the overflow process and a near bottom plume by the draghead resuspension; 900 to 1200 ft behind the dredge the two plumes merge into a single plume. In the immediate vicinity of a hopper dredge working in fine-grained material in Grays Harbor, Washington, the surface plume of suspended solids behind the dredge was 200 ft wide by 4000 ft long with suspended solids concentrations reaching 891 mg/l at a distance of 100 ft behind the dredge. Suspended solids concentrations in the surface waters were less than 100 mg/l, 1000 feet astern of the dredge. The near bottom plume had a width of greater than 400 ft and a length of approximately 8500 ft. Near bottom suspended solids concentrations remained greater than 100 mg/l at 1500 ft behind the dredge.

The sediment resuspension associated with hopper dredges not using hopper overflow was considerably less than that with dredges overflowing their hoppers. At Grays Harbor, a surface suspended sediment plume was not detected behind a now-overflowing hopper dredge. The highest suspended sediment concentration recorded for the non-overflowing hopper dredge was 70 mg/l in near bottom samples.

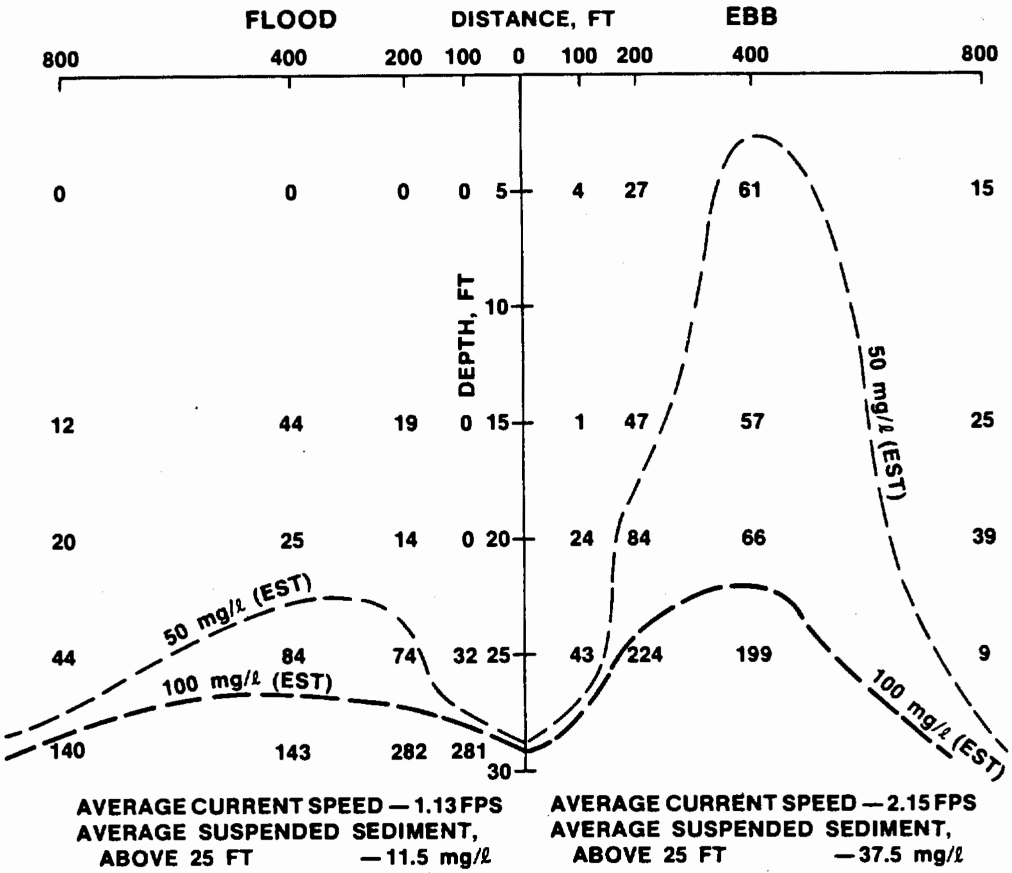


FIGURE 21

SCHEMATIC OF AVERAGE SUSPENDED SEDIMENT CONCENTRATIONS (LESS BACKGROUND CONCENTRATIONS) FOR INDICATED DEPTHS AND DISTANCES FROM A HYDRAULIC PIPELINE DREDGE, JAMES RIVER, VA (RAYMOND, 1984).

For a clamshell dredge, sources of resuspended sediment include: material resuspended as the bucket impacts and is pulled loose from the bottom; material within or adhering to the bucket that are washed loose as the bucket moves through the water column; material that spills or leaks out of the bucket when the bucket breaks the water surface; inadvertent spillage of material during barge loading or intentional barge overfilling. A method to predict the combined effects of variables, such as bucket size and type, hoisting speed, loading methods, sediment types, and hydrodynamic conditions at the dredging site, or spatial and temporal changes in suspended sediment conditions that will occur during a specific project does not exist (Lunz et al., 1984). However, Barnard (1978) suggested that a typical clamshell dredge operation produces a downstream suspended solids plume that extends for 1000 feet at the surface and 1650 ft at the bottom. Maximum concentrations of suspended solids in the surface plume should be less than 500 mg/l in the immediate vicinity of the dredge and decrease rapidly with distance from the dredge.

The Wilmington District, U.S. Army Corps of Engineers conducted a field study of clamshell dredging and barge overflow at the Military Ocean Terminal, Sunny Point (MOTSU), North Carolina in 1987. The results of this study are presented in Payonk et al. (1988) and Palermo et al. (1988) and summarized in the following paragraphs.

Sediments dredged during the maintenance dredging of MOTSU were predominantly highly plastic clays with traces of sand. The clamshell dredging produced visible plumes of turbid water. Because of the cyclic nature of the clamshell bucket operation, plumes resulting from bucket spillage and overflow formed a series of patches which, as they were advected down-current, tended to spread and merge. The plumes were not visible at distances greater than approximately 1000 ft down-current to observers in boats.

Approximately 600 water samples were taken from the stations shown on Figure 22 coinciding with clamshell dredging on September 24 and 30 and clamshell dredging with barge overflow on October 20. This total sampling effort produced 4 measurements which exceeded 25 NTUs, the North Carolina water quality standard for turbidity in the waters of the Cape Fear River at MOTSU. All values greater than 25 NTUs were from bottom (30 feet) samples and ranged from 33 to 27 NTUs.

Figure 23 illustrates turbidities at specific up- and down-current stations relative to the dredge. Because of the significant tidal currents at MOTSU, up-current stations can be designated as control or background stations and down-current stations as effected stations. For September 30, station B1 was down-current, on flood tide, from 0900 through the end of the sample day. Station B3 was up-current of the dredge for that same period. Differences between up- and down-current turbidities for September 30 (a dredging only day) were generally less than 5 NTUs. For October 20 (a dredging and overflow day), station B1 is up-current, on ebb tide, from 0800 until approximately

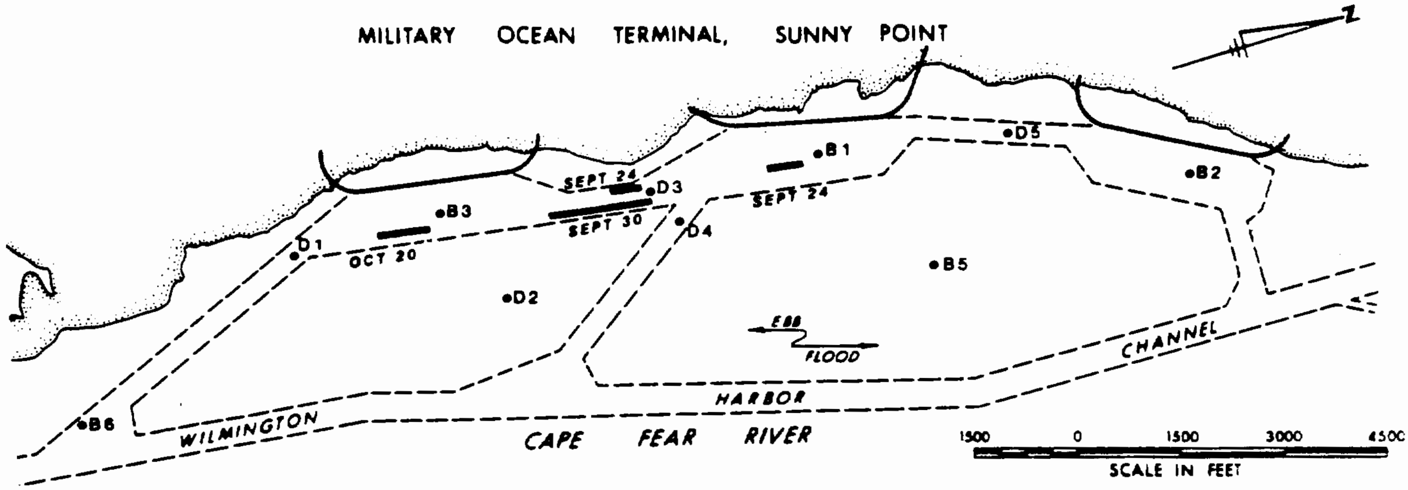


Figure 22. MOTSU clamshell dredge study area. Plume sampling stations and areas dredged on specific days (bars with dates) are shown (from Payonk et al. 1988).

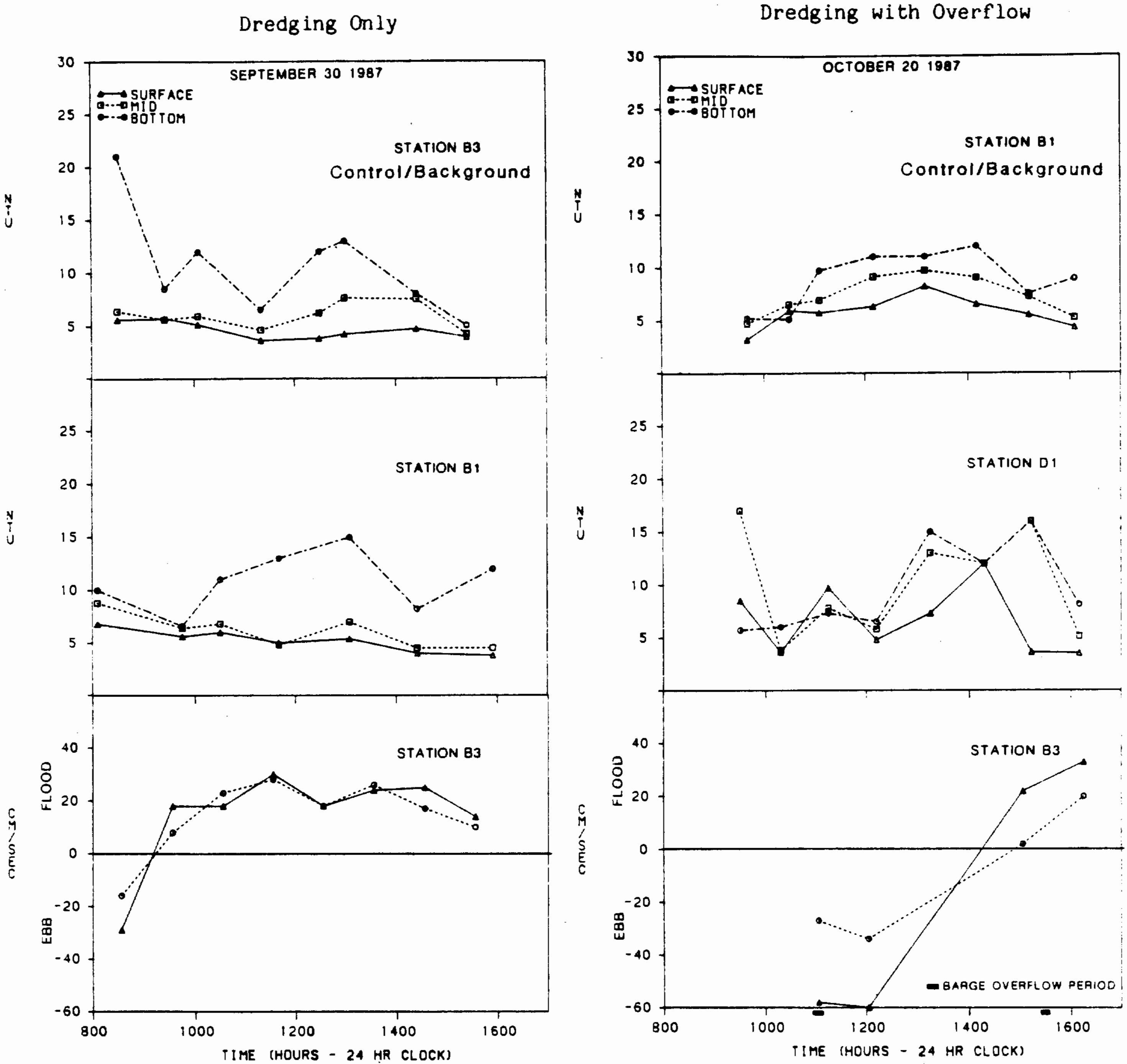


Figure 23. Turbidities measured up- and down-current of a clamshell dredge. Measurements of September 30 are dredging only while those of October 20 include two barge overflow periods as indicated. Current speed and direction for those days are also shown. Stations are shown on Figure 22 (from Payonk et al. 1988).

1400 when the tide changes. Station D1 is down-current of the dredge for the majority of the sample day. Station D1 exhibited fluctuations in turbidity that may be due to dredge-induced perturbations. Station D1 was within 1300 ft of the dredge and the fluctuations may be patchy near-field phenomena not seen in the comparison of September 30 where the down-current station B1 was approximately 2,600 ft down-current.

In addition to the above described observations made within a grid of stations in the MOTSU navigation basin, turbidity and suspended solids concentrations "spot" samples were taken very close to the dredge and in the sediment plume. A conscious effort was made to take these samples from the sediment plume. The plume was located either by fathometer or by in situ nephelometric measurements before the sample was taken. Maximum turbitities, measured within 10 feet of the transportation barge during barge overflow, were 72 NTUs at the surface and 150 NTUs at a depth of 30 ft. Suspended solids concentrations in the water samples with 72 and 150 NTUs samples were 327 mg/l and 739 mg/l, respectively. The results of plume sampling taken 100 - 1,000 ft down-current from clamshell dredging and simultaneous dredging and overflow activities are given in Table 11. These data indicate that turbidity returns to near-background levels short distances down-current from clamshell dredging and dredging and barge overflow activities.

Table 11. Water column averaged turbidity (NTU) measured at varying distances from a clamshell dredging activity at MOTSU. Measurements were taken at 2, 15, and 30 ft depths and then averaged. The October 20 profiles were taken during overflow.

	100 ft Down-Current				1,000 ft Down-current				Background			
Date	mean	range	(s.d.	n)	mean	range	(s.d.	n)	mean	range	(s.d.	n)
Sept. 24	17.6	9.8-24	(5.9	15)	10.3	7.9-18	(3.8	12)	7.7	1.2-17	(3.3	41)
Sept. 30	9.5	4.3-20	(5.5	9)	10.8	4.7-24	(7.0	9)	7.6	2.8-21	(4.3	60)
Oct. 20	28.8	5.8-58	(18.0	6)	9.4	5.8-13	(3.3	6)	4.4	3.6-6.6	(0.8	12)

In summary, clamshell dredging and dredging with barge overflow of fine-grained maintenance materials produces turbidity plumes that return to near-background levels short distances down-current from the dredging activity. The water quality effects of clamshell dredging of coarser material should be even more restricted to the dredging site than those observed with this study.

Saltwater Intrusion. The proposed action involves only maintenance and does not include any navigation channel deepening. Therefore, the saltwater intrusion conditions discussed in section 4.1.4.2 will not be altered by the proposed action.

5.2 Biology of Dredging and Disposal Sites.

5.2.1 Aquatic Biology

5.2.1.1 Nekton. The water quality affects produced in the Cape Fear River during the Wilmington Harbor maintenance dredging with either a hydraulic pipeline dredge, clamshell dredge, or hopper dredge will be short-term and are not expected to have significant adverse impacts on estuarine or marine nekton. Also, the disposal of dredged material in diked upland areas, or in the Wilmington Harbor ODMDS is not expected to have significant adverse impacts on estuarine or marine nekton. Fish and shellfish species inhabiting the Wilmington Harbor project vicinity are adapted to, and highly tolerant of, naturally elevated suspended sediment concentrations. In reviews of laboratory tests, Hirsch et al. (1978) and Stern and Stickle (1978) found marine and estuarine organisms to be very tolerant of the effects of sediment suspensions. Lethal or sublethal effects on larval or adult fish or shellfish occur after longer exposures to higher concentrations of suspended sediment than typically occur in the water column during dredging and disposal (Peddicord and McFarland 1978; Preist 1981).

Bioassay and bioaccumulation tests using Keg Island and Baldhead Shoal channel sediments indicate that those sediments did not differ significantly from reference sediments in their affects on estuarine and marine organisms (US Army Corps of Engineers 1980 and 1986a). The reference sediment represents background conditions away from the influence of any disposal operation.

The potential for interruption of the movement of estuarine fish and shellfish and particularly anadromous species of fish to and from nursery and spawning areas in the Cape Fear estuary by the physical presence of dredging equipment or by the physical-chemical water quality alterations associated with dredging is not well known. However, river currents or flows upon which larval organisms depend for transport will not be interrupted or reduced. Dredged induced water quality conditions will only be short-term and impact a small cross-sectional area of the Cape Fear River; therefore, the potential for blockage of migration routes will be minimal.

Entrainment of Estuarine Larvae and Fishes By Hopper and Hydraulic Pipeline Dredge. The reported or estimated entrainment rates of fish and shellfish by hopper and hydraulic pipeline dredges are low, indicating that dredging causes a minimal direct mortality (Arseneault 1981; Armstrong et al. 1982; Carriker et al. 1986). However, the potential for entrainment of a larger percentage may be significant during certain periods of the year or under certain site specific conditions but long-term productivity will not be adversely impacted. The potential for entrainment is increased in restricted bodies of water such as narrow channels when mobile organisms may not be able to avoid the dredge or when passive organisms may be concentrated. The following physical and biological factors are given as an analysis of the potential for dredge entrainment impacts in the Cape Fear River.

The hydraulic pipeline dredge consists of mechanical action of a rotating cutterhead to loosen bottom material and hydraulic action by a pump to transport it to the disposal area. The material transported consists of a slurry of approximately 20% solids and 80% water, depending greatly on the characteristics of the bottom sediment. Considerable amounts of water can be contributed from the bottom material itself; however, water is also taken from the overlying water column. The suction-velocity field or entrainment field will extend over only a small area in the vicinity of the dredge cutterhead at the river bottom. For example, MacNair and Banks (1986) determined that a 12 inch dredge with an intake 2 feet above the bottom at a depth of 18 feet and a suction velocity of 10 ft/sec **(7.85 cfs)** generated a velocity field of .13 and .06 feet/sec at distances of 2.5 and 5 feet from the intake, respectively. Considering the **average daily** Cape Fear River **freshwater** inflow **of 9,700 cfs**, currents **generally ranging from 0.6-2 ft/sec, average tidal amplitude of 4 feet**, and river bed dimensions, the volume of water removed by the dredge is insignificant compared to the volume of water in the river.

As indicated in section 4.2.1.4, seasonal variations in abundances and life stages occur and are triggered by complex hydrological and climatological factors. Also, the distribution of organisms in the water column is not uniform. Species specific vertical migrations of larval organisms in the water column depending on light and tide conditions have been reported. The complexity of the biological variables indicates that some organisms at some life stage will be available for entrainment at any time of the year.

In conclusion, the dredge induced (entrainment) mortality of estuarine organisms associated with dredging of the Wilmington Harbor project is unknown but is believed to be insignificant based on the short-term duration, physical characteristics of the dredging activity and the magnitude of Cape Fear River water movements in comparison to those caused by the dredge.

Schedule of Dredging and Dredging Window. Maintenance dredging of Wilmington Harbor channels by hydraulic pipeline or clamshell dredge will normally be scheduled between October 1 and March 31 of any given year, the "dredging window" established by the N.C. Division of Marine Fisheries and N.C. Division of Coastal Management. Hopper dredging of the Battery Island to Baldhead Shoal, Cape Fear River Inlet area, is currently scheduled on the basis of need for dredging and availability of the dredge, at any time of the year. A requirement to dredge outside the specified window may arise. If this occurs, prior approval will be sought from the N.C. Division of Coastal Management and the N.C. Division of Marine Fisheries. Examples of conditions which may lead to a need to dredge outside the dredging window may include unpredictable episodic shoaling which creates navigational hazards and operational considerations such as dredge availability and dredge capabilities.

5.2.1.2 Benthos. Regardless of the dredging method used, removal of the substrate will eliminate all benthic resources in the area to be dredged. This will not be an irreversible loss since benthic resources will repopulate the area rapidly from nearby areas that are not dredged. The density and diversity of the population that reestablishes will depend on the frequency of dredging, but the populations that reestablish should be similar to those eliminated since the species are substrate dependent and new sediments should be the same as that removed. All of the benthic populations are in a state of flux due to dredging that has been conducted for approximately 150 years and due to sedimentation that causes the need for maintenance dredging. Any significant concentrations of sediments suspended during dredging operations should be confined to the ship channel due to strong currents. The use of a hydraulic pipeline dredge requires at times that the pipeline be laid across the bottom in order to reach the diked disposal area. Since the pipeline is laid on the bottom for a short time, the impacts to benthic resources are not significant. Therefore, based on the above discussion, no significant adverse impacts are anticipated on benthic resources due to dredging.

The impacts of dredged material disposal within the Wilmington Harbor ODMDS were addressed in the final environmental impact statement for designation of the ODMDS (USEPA 1983). That document recommended the Wilmington Harbor ODMDS as an environmentally acceptable ocean location for the disposal of dredged materials which comply with EPA's Ocean Dumping Regulations and Criteria (40 CFR 220-229). Further, the impacts of the disposal of dredged materials from specific channels of the Wilmington Harbor project were addressed in the Corps of Engineers' final environmental impact statement, Maintenance of Wilmington Harbor (US Army Engineer District, Wilmington 1977) and in the environmental assessment, Maintenance Dredging with Clamshell Dredge and Ocean Dumping, Keg Island to Snow Marsh Channels (US Army Corps of Engineers, Wilmington District 1986b).

As discussed in Section 4.1.4.2, the chemical and biological tests of representative sediment materials from the Wilmington Harbor project are reported in U.S. Army Corps of Engineers (1980 and 1986a). These tests indicate that the sediments from Wilmington Harbor (Baldhead Shoal to Lower Big Island, inclusive) meet the testing criteria of the EPA Ocean Dumping Regulations and Criteria. Bathymetric surveys of the Wilmington Harbor ODMDS conducted in 1984 and 1986 indicated no mounding of dredged materials or evidence which would indicate that the site was at or near disposal capacity. The 2.3 square nmi area should have sufficient capacity to contain additional dredged material from Wilmington Harbor channels beyond the 50 year planning period.

Based on the information presented above, disposal of dredged materials from the Wilmington Harbor project, Lower Big Island channel downstream to Baldhead Shoal Channel inclusive, within the Wilmington Harbor ODMDS will not significantly degrade or endanger the marine environment, ecological systems, or human uses of the marine environment.

5.2.1.3 Plankton. The primary potential impacts of dredging activities on phytoplankton and zooplankton are the increase in suspended sediment concentrations and turbidity and entrainment of the organisms by pipeline dredges.

Turbidity equal to or greater than that created by dredging is frequently noted in the Cape Fear River under natural conditions. Turbidity caused by dredging will essentially be confined to the navigation channel because of the strong tidally induced currents there. Effluent from diked disposal areas will be returned to the vicinity of the navigation channel (except for disposal areas 15 and 16). The turbidity from all diked disposal sites should be minimal since the effluent is controlled by adjustable spillways.

Phytoplankton are concentrated near the surface and zooplankton (depending on species) are scattered throughout the water column and both are found in and out of the ship channel. Therefore, removal of these organisms by the dredges is not deemed significant. Similar dredging activities have been conducted in the river for years without any apparent adverse impact.

5.2.1.4 Estuarine Nursery Areas. Since the project only involves maintenance and no disposal in the estuarine nursery areas is proposed, impacts to the estuarine nursery areas will be similar to that indicated in section 5.2.1.1.

5.2.2 Terrestrial Biology.

5.2.2.1 Flora. As a result of dredged material deposition, all sites which will be used in the long-term maintenance of the project can be expected to develop mixed early successional stage communities within diked disposal areas. These communities will probably be dominated by *Phragmites australis*, a hardy competitor which dominates the interiors of the diked disposal areas in the region today. During the diking of islands which are presently undiked (11-13 and 18) and rediking on existing diked islands, the various types of plant communities will be irreversibly changed. The proposed dike alignments are shown overlaying the existing vegetation communities on figures 4-20. As can be seen from the figures, many types of plant communities will be incorporated into these disposal areas, ranging from brackish marsh to upland forested. Table 7 gives the acreages of vegetation community types which will be affected at each disposal site under the proposed maintenance plan. See section 5.2.4 for a discussion of mitigation for the significant irreversible resource losses.

The impacts of dredging pipeline laid across marsh or other vegetation to reach the disposal areas should be short-term and minor. The vegetation should quickly recover following pipeline removal.

When dikes are constructed or rebuilt, heavy equipment such as bulldozers, backhoes and draglines are used. Occasionally temporary earth loading and unloading ramps from barges are needed to get the heavy equipment to the disposal islands. Construction of the ramps will be avoided in areas with significant resources such as marsh. Therefore, ramp construction will have minor and short-term impacts.

Prior to each ramp construction, a consistency determination will be sent to the NC Division of Coastal Management for concurrence/nonconcurrence. A Section 401 (PL 95-217) Water Quality Certification (No. 2020, February 4, 1987) has been issued for this activity.

5.2.2.2 Fauna. In existing dredged material disposal areas, impacts on fauna from future maintenance will be similar to the impacts taking place with maintenance at this time. These impacts consist of periodic burial and/or inundation of habitat during dredged material disposal and associated loss of nests, young, den sites, etc. The severity of impact from any given disposal operation is dependent on the time of year when disposal takes place. Species of animals commonly found in diked disposal area interiors such as marsh rabbits, hispid cotton rats, and red-winged black birds have a high fecundity and do not suffer any long-lasting population declines as a result of disposal impacts.

At disposal sites not previously diked, impacts on fauna will be dramatic and irreversible. In areas such as sites 11, 12, 13, and 18, all faunal forms associated with the forested or shrub habitats will be lost as these habitats will be removed by either dike construction or dredged material disposal. The faunal communities of these areas will decline in species diversity and become similar to those of already existing disposal areas.

As indicated in section 3.6.2, waterbird nesting islands in the lower Cape Fear region will only receive dredged material intermittently. Disposal of dredged material in colonial waterbird nesting areas will normally be undertaken only as a management measure and will be coordinated with natural resource management agencies prior to deposition.

Dredged material disposal sites which receive a high percentage of fine materials (silts and clays), have the potential to become ideal mosquito breeding habitat. As it dries and compacts, such dredged material will form an intricate network of cracks, extending from the surface down to a depth of nearly one foot. The sides of these cracks are then used as attachment sites for eggs by female mosquitoes. When rain water fills these cracks, the eggs hatch out and, in a matter of about one week, huge swarms of the newly hatched mosquitoes become airborne. In the past, there have been several instances of nuisance mosquito outbreaks from the Eagle Island disposal area located directly across the river from the City of Wilmington.

The USACE now contracts with the Brunswick County Board of Commissioners for surveillance and control of mosquitoes on all disposal islands within Brunswick County, except for aerial spraying of pesticides on Eagle Island. Due to the large size of Eagle Island (880 acres), personnel with Brunswick County perform surveillance but the USACE contracts for aerial application of pesticides which consists of one larvicide and one adulticide. The larvicide used is *Bacillus thuringiensis* var. *israelensis* (BTI). This larvicide has proven very effective against mosquitoes and a few other insects but extensive research has indicated the BTI is not toxic to non-target organisms such as mammals, fish, shellfish and amphibians (e.g. Sebastien and Brust 1981; Purcell 1981).

The adulticide used is malathion and is applied by aerial ultra-low-volume (ULV) equipment. Malathion is the most common mosquito adulticide used in North Carolina and many other states and the North Carolina Division of Health Services believes that malathion (using ULV equipment) does not present significant health risks (NC Department of Human Resources 1988). In field studies, the application of malathion at the recommended use rate has not generally affected annelid, reptilian, amphibian, avian, or mammalian populations. Excessive mortality in fish and other aquatic organisms, as indicated by the results of laboratory studies, has generally not occurred in the field, but significant reductions in nontarget aquatic insects have resulted from field applications (American Cyanamid Co. 1986). Impacts to non-target organisms outside the Eagle Island boundaries are not anticipated to be significant due to the use of ULV equipment, spraying during low wind conditions (< 5 m.p.h.), short residual time of malathion and no dredged material disposal or releases from the disposal area spillways for at least 7 days after spraying. Should aerial drift occur, impacts on aquatic fauna in either the Brunswick or Cape Fear Rivers should be imperceptible as the small amount of pesticide reaching those rivers will be greatly diluted and rendered non-toxic. The last malathion aerial spraying was in August 1987.

In addition to the above control measures, Brunswick County personnel have introduced mosquitofish (Gambusia affinis) into the Eagle Island disposal area each spring since 1982 for biological control of mosquito larvae. The disposal area spillways have been adjusted to allow water to remain on the site so that the mosquitofish have access to the breeding sites. In order to control minor problems, the county periodically sprays malathion from the disposal area dikes using truck mounted ULV equipment.

Both malathion and BTI are EPA registered and are applied by licensed applicators in accordance with label directions. This program appears to be effective in managing the nuisance mosquito problem and will be continued as a part of future maintenance of the harbor.

The potential need for a mosquito surveillance and control program for New Hanover County disposal sites will be discussed with New Hanover County officials before the next diked disposal actions covered under this final EIS.

5.2.3 Wetlands and Floodplains. The proposed action would eliminate wetlands by diking, grading and disposing in areas 11, 12, 13 and 18 (the wetlands in sites 15 and 16 have received previous environmental clearances, section 4.2.3; section 5.2.4 discusses the wetlands eliminated at site 18). These wetlands are indicated in table 12 and described in section 4.2.3. All four sites have been altered previously by the disposal of dredged material and all other dredged material disposal alternatives have greater environmental impact (section 3.5)

If the wetlands were left intact on sites 11 through 13, the wetlands would essentially "pinch-off" part of the disposal areas (especially as the height and width of the dikes increased over the 50 year maintenance period). This would reduce the required disposal capacity and impair settling of sediment in the disposal areas.

These wetland losses will not be irretrievable since a total of 7.5 acres of high marsh and 7.5 acres of intertidal marsh will be planted along the shoreline of islands 11, 12, and 13 to stabilize the shoreline and the new dike (section 3.2.2). The grading and diking process will result in the loss of 6.3 acres of high marsh and 0.5 acre of intertidal marsh (table 12). The result is a total net increase of 1.2 acres of high marsh and 7.0 acres of intertidal marsh. This activity is not mitigation but rather an integral part of project planning and design.

All the existing disposal areas are located in the 100 year floodplain and there are no practicable alternatives available that would have less environmental impact (section 3.5). Impacts have been minimized as indicated in sections 5.2.3 and 5.2.4. The State of North Carolina and New Hanover County are sponsors of the proposed action and as such the proposed action conforms to applicable State and local floodplain protection standards.

TABLE 12

WETLANDS INVOLVED IN THE PROPOSED ACTION

Dominant Wetland Type	Within Diked Area Site No. 11	12	13	Total Graded Area Site No. 11, 12 & 13	Total Marsh High	Intertidal*	Wooded Wetlands, Site No. 18 Covered by: Dredged Material	Access Road	Created Wetland Site No. 11,12 & 13
Common reed	2.0		2.0		4.0				
Black needlerush/ with giant cordgrass		0.5			0.5				
Sawgrass with giant cordgrass			1.0		1.0				
Red maple							10.0	0.2	
Common cottonwood							4.0	0.8	
Intertidal marsh (saltmarsh cordgrass)				0.5		0.5			7.5
High marsh (salt meadow hay)									7.5
Mixed high marsh				0.8	0.8				
Totals	2.0	0.5	3.0	1.3	6.3	0.5	14.0**	1.0	15.0

* Between mean high water and mean low water.
** Only filled if additional disposal capacity needed due to unexpected shoaling.

5.2.4 Mitigation Plan for Site 18. The 28 acres of terrestrial habitat lost at the site will not be mitigated since it is not considered to be a significant resource. The site has limited wildlife habitat value due to its small size and isolation. This terrestrial habitat is described in section 4.2.2. The US Department of Interior by letter of June 2, 1988 and the NC Wildlife Resources Commission by letter of May 13, 1988 disagreed with the decision indicated above that the loss of terrestrial habitat at site 18 will not be mitigated. See appendix A for the reponses to these letters.

Site 18 (figure 19) contains 26.5 acres of wetlands. Disposal of dredged material at this site could impact up to 14 acres of wooded wetlands in two ways. First, the 14 acres of wooded wetlands at the site may be needed for the disposal of dredged material if there is an unexpected increase in shoaling. This wooded wetland is located between the upland and railroad. If this 14 acres of wetlands is needed for additional disposal capacity, it would not be needed for 30 or more years. A wetland mitigation plan would be developed then so as to result in no net loss in quantity and quality of wetlands that exist on the site at that time.

Second, a permanent access road is needed to disposal site 18 for equipment to build and maintain dikes. In addition, the road could be used by trucks in order for New Hanover County (the local sponsor) to sell the dried dredged material, or if the material is suitable, it could be used for daily cover at the county landfill. Either way, removal of dredged material would extend the life of the disposal site. The county will attempt to arrange, with the adjacent property owner, for permanent upland road access to the site. If this is not possible, the least adverse impact from road access would require the filling of up to 1.0 acre of wooded wetlands. No separable mitigation is required for this potential 1 acre wetland loss because:

New Hanover County proposes to purchase site 18 as part of the local sponsor's responsibility to provide dredged material disposal areas. By means of this ownership, the local sponsor will protect from filling, logging, draining or other alteration the 4.5 acres of isolated wetlands in the southwest corner of the site and 8.0 acres of wetlands bordering the Northeast Cape Fear River. In addition, the 14 acres of wooded wetlands located between the upland and railroad will be protected by the local sponsor from filling (except for the access road), logging, draining or other alteration until the area is needed (if ever) for disposal of dredged material due to unexpected shoaling.

5.3 Threatened and Endangered Wildlife, and Plants. Under Section 7 of the Endangered Species Act of 1973, as amended (hereafter referred to as the Act), biological assessments of the effects of the maintenance of Wilmington Harbor were prepared on those species listed in Section 4.3. These assessments were mailed to the US Fish and Wildlife Service and the National Marine Fisheries (NMFS) Service on July 29 and July 26, 1988, respectively. By letter of September 26, 1988 (appendix F), the US Fish and Wildlife Service indicated that the biological assessment was adequate, agreed with the conclusion of no effect and stated that compliance with the Act was satisfied.

By letters of December 23, 1988 and January 13, 1989 (appendix F), NMFS determined that dredging may affect the right whale, shortnose sturgeon and three sea turtles (green turtle (Chelonia mydas), Kemp's ridley turtle (Lepidochelys kempi), and loggerhead turtle (Caretta caretta)). NMFS indicated that maintenance activities would not jeopardize the continued existence of the species but identified reasonable and prudent measures to be implemented. The mitigation measures are as follows:

"1. A preliminary gill net survey of the project site will be conducted to determine the presence of shortnose sturgeon. This survey will be completed prior to dredging." (This survey is not needed since the distribution and abundance (D&S) survey indicated in the 'conservation recommendation' began 11/88. Two shortnose sturgeon (one died, one tagged) have been caught to date since 11/88. More comprehensive D&S suveys are in the planning stage.)

"2. If the preliminary survey indicates large concentrations of sturgeon or if sturgeon mortalities are observed during dredging, the USACE should be prepared to implement a plan to capture and remove shortnose sturgeon from the immediate vicinity of the project.

3. The (dredging) contractor will advise workers that there are civil and criminal penalties for harming, harassing or killing sea turtles, or shortnose sturgeon which are protected under the Endangered Species Act of 1973, as amended. The contractor will keep a log detailing all sightings, collisions, damage or killing of sea turtles or shortnose sturgeon, and shall be held responsible for any listed species harmed, harassed or killed as a result of dredging.

4. Any take of sea turtles or shortnose sturgeon resulting in injury or death to the animal will be reported immediately to the Wilmington District Corps of Engineers and to NOAA Fisheries Southeast Regional Office.

5. If hopper dredges are used, vessels should be adequately screened to document turtle or shortnose sturgeon mortalities, and a minimum 25% observer coverage should be maintained."

In addition, a watch will be instituted for the right whale aboard the dredges during December - April to assure that dredge/whale collisions are avoided during transit to and from the ocean dredged material disposal site.

The impacts of pesticides were not discussed in the biological assessments, but mosquito pesticide treatments of disposal islands should not impact threatened or endangered species since no such species are known to inhabit any of the disposal islands. Also, BTI is not toxic to non-target organisms and any drift of malathion from the disposal areas should not adversely impact the surrounding waters (section 5.2.2.2).

5.4 Areas of Archaeological and Historic Significance. The maintenance of the Wilmington Harbor project as outlined in this document will not have any adverse effect on significant cultural resources. No new dredging is proposed and all of the disposal areas proposed for use over the 50-year planning period have received dredged material previously.

5.5 Socioeconomic Considerations Related to Wilmington Harbor.

5.5.1 Land Use. Under the Brunswick and New Hanover Counties Land Use plans the dredged material disposal areas fall in one of two classifications as described in section 4.5.1. The USACE proposed maintenance activities are consistent with these classifications. See section 5.6 for the consistency determination for the North Carolina Coastal Management Program.

5.5.2 Projected Port Growth, Income and Employment. Without the maintenance of Wilmington Harbor, the employment and related income, commerce, and revenues (section 4.5) would be severely impacted and eventually the port would close due to shoaling in the river. This would also result in the irreversible and irretrievable loss of the following projected port growth.

From the National Waterways Study (1981) projections, for all commodities handled for the South Atlantic Coast, from the base year of 1977 through the year 2003, indicate an increase of 16.3 percent, for an annual compound growth rate of 0.6 percent. These projections are shown in figure 24. The general trend is toward reduced petroleum products movements and increases in chemicals and in the pulp and paper group. This follows generally the trend of recent years for product movements through Wilmington Harbor. A relationship between port activities and economic growth of the Wilmington area was indicated in the Corps' feasibility report for improvements to Wilmington Harbor (US Army Corps of Engineers, Wilmington District 1979). In this report commerce through the port was considered a determinant to total income and population growth in the area.

While this report projected significant tonnage growth from 1976 to 1986, actual tonnage has decreased. Future projections working from a 1982-86 base of 5-6 million tons per year would also be expected to increase, but no growth rates have been developed.

The Research Triangle Institute (RTI 1983) conservatively projected tonnage through the NCSPA facilities to increase at an average annual compound rate of 3.1 percent between the years 1980 and 2000, assuming only two container cranes in operation. (Currently, there are three. In November **1989** two additional cranes are planned to begin operation.) The rate would vary from 4.2 percent annually from 1980 to 1990 and 1.9 percent between 1990 and 2000. Additional information on the economic value of Wilmington Harbor is included in Appendix D of the **final** EIS.

5.5.3 Recreation and Esthetics. In the future, pipeline dredging activities and use of disposal islands in the lower river will be reduced. This will reduce some of the congestion caused by pipelines, thus improving recreation use. As disposal on the islands is eliminated or reduced, succession will take place and the esthetics of the lower river will also improve.

Dredging and disposal activities in the upper river will not change significantly from the past over the 50 year planning period. The height of the dikes around areas 15, 16 and 18 will be increased but, the disposal areas proposed for use under this maintenance plan are isolated from view and their use, therefore, should have minimal impacts on the esthetics of the region.

5.6 Consistency Determination for the North Carolina Coastal Management Program. Based on the information contained in this **final EIS**, the long-term maintenance of Wilmington Harbor is consistent with the Coastal Management Program of the State of North Carolina.

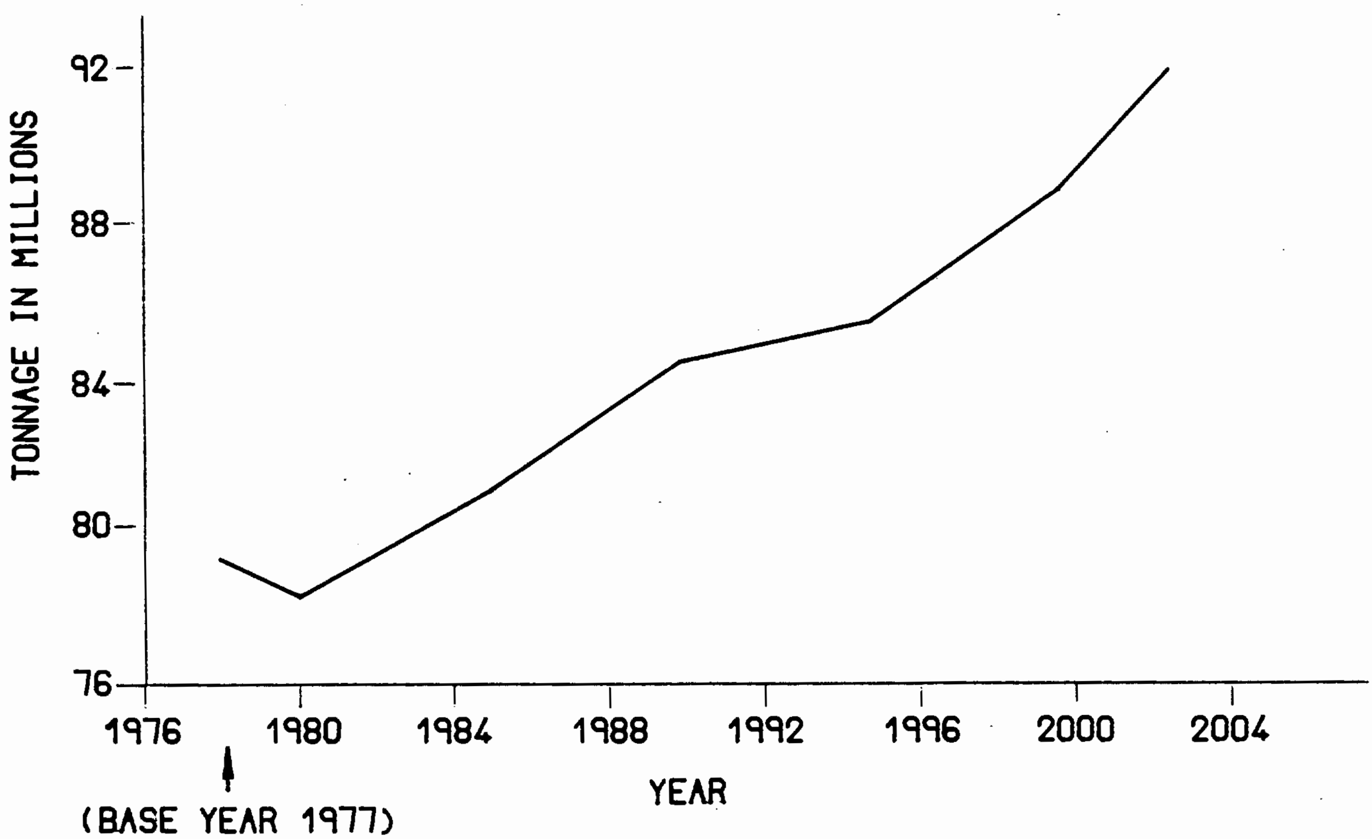
FIGURE 24

PROJECTIONS[1] OF ALL COMMODITIES

BY TONNAGE

SOUTH ATLANTIC COAST SEGMENT [2]

1977-2003



[1] TRENDLONG 2003A ANALYSIS
[2] FROM KEY WEST TO NC-VA BOUNDARY
SOURCE: NATIONAL WATERWAYS STUDY (1981)

6.0 LIST OF PREPARERS

The following Corps of Engineers personnel were primarily responsible for preparing this Environmental Impact Statement:

Name	Discipline/ Expertise	Experience	Role in Preparing EIS
William F. Adams	Biology	6 months National Park Service; 13 years, Environmental Resources Branch, Wilmington District	Project planning and assessing impacts on wildlife
John A. Baden	Biology	2.5 years environmental biologist, Federal Power Commission; 1 year biologist, Savannah District; 2.5 years environmental specialist, Fort Eustis, Va.; 10 years biologist, Wilmington District	Vegetation mapping
Christina E. Correale	Environmental impact and water quality assessment	5 years chemist, 7 years Chief, Water Quality Section, 2 years Chief, Environmental Resources Branch, Wilmington District	Supervisor
Ed Croom	Realty specialist	30 years experience in the real estate field	Coordinate all real estate actions
Tong Haw	Geology	14 years geotechnical and foundation and materials	Evaluate geologic matters
Barry Holliday	Civil Engineer/ dredged material disposal management	5 years marine research, 4 years dredging research, Waterways Experiment Station; 11 years Chief, Navigation Br., Wilmington District	Coordinator on navigation and dredging issues
Richard H. Kimmel	Archaeology	1.5 years archaeological technician, Univ. of South Carolina; 9 months archaeologist, Univ. of North Carolina; 10 years Environmental Resources Branch, Wilmington District	Underwater archaeology surveys and assessment

Name	Discipline/ Expertise	Experience	Role in Preparing EIS
Ben Lackey	Civil and Soils Engineer	1 year cost estimating, 9 years soil engineering, Wilmington District	Dike design
Philip Payonk	Biology	5 years oceanographer, U.S. Naval Oceanographic Office; 8 years biologist, Wilmington District	Dredging and disposal impacts
Frank Reynolds	Economics	7 years flood plain management, 6 years economics, Wilmington District	Prepare economic and social analysis
Frank Snipes	Economics and water resource planning	10 years economic analysis, 8 years study management, Wilmington District; 1 year planning associates, Board of Engineering for Rivers and Harbors	Future navigation improvements
Mike Wutkowski	Civil and Coastal Engineer	11 years coastal engineer, Wilmington District	Beach disposal
G. Frank Yelverton	Biology	3 years marine research, 2 years dredge and fill permits State of North Carolina; 8 years Regulatory Branch, 5 years Environmental Resources Branch, Wilmington District	Water quality and EIS manager

7.0 PUBLIC INVOLVEMENT

On July 19, 1985, a scoping meeting was held with Federal and state agencies and local environmental groups to identify pertinent issues to be addressed in the draft EIS. Discussions, including on-site investigations, have continued with these groups throughout preparation of this final EIS. Agencies and groups represented at the scoping meeting were:

US Fish and Wildlife Service
US Environmental Protection Agency
National Marine Fisheries Service
US Army Corps of Engineers
NC Division of Environmental Management
NC Division of Marine Fisheries
NC Department of Cultural Resources
NC Division of Coastal Management
NC Wildlife Resources Commission
NC Division of Water Resources
Sierra Club
North Carolina Coastal Federation

On July 23, 1987, a notice of intent to prepare an EIS was published in the Federal Register (52 FR 141).

The draft EIS was mailed to a standard list of Federal, state and local governments; environmental groups; and libraries; and other interested businesses, groups and individuals on March 29, 1988. The notice of availability of the draft EIS was published in the Federal Register (53 FR 73) on April 15, 1988 and a public notice for the project was issued April 11, 1988. The comment period for the draft EIS and public notice expired June 10, 1988. Comments were requested from all recipients. Comments received are included in appendix A along with responses. These comments were considered in the preparation of this final EIS.

The mailing list for this final EIS was essentially the same as for the draft EIS. This mailing list is indicated in table 13. A public notice on the proposed action including a notice of availability of the final EIS will be issued and a copy of the final EIS will be sent to anyone requesting it. Comments were requested from all recipients of the final EIS and will be used in preparation of the Record of Decision on the proposed action.

TABLE 13

Mailing List for the Final EIS

Federal Agencies

Environmental Protection Agency
Forest Service, USDA
Regional Environmental Officer
    HUD, Atlanta Regional Office,
Advisory Council on Historic Preservation
National Oceanic and Atmospheric Administration
Federal Emergency Management Administration
Department of Health and Human Services
National Marine Fisheries Service
Department of the Interior
Fish and Wildlife Service
Fifth Coast Guard District
Federal Highway Administration
Soil Conservation Service, USDA
Department of Energy
Commanding Officer
    USCG Base Fort Macon
Commanding Officer
    Wrightsville Beach Station-USCG
Commander
    Military Ocean Terminal, Sunny Point
Commanding General
    Camp LeJeune, North Carolina
Officer in Charge
    USCG Station Oak Island

Conservation Groups

National Wildlife Federation
Conservation Council of North Carolina
National Audubon Society
N.C. Wildlife Federation
Environmental Defense Fund, Inc.
State Conservationist, Sierra Club
Cape Fear Group Sierra Club
Capitol Group, Sierra Club
Izaac Walton League
N.C. Coastal Federation
Dr. Anne B. McCrary
Dr. Vince Bellis
Mr. James Dockery

Table 13 (continued)

State Agencies and Officials

State Clearinghouse
Mr. John N. Morris, Director
    Division of Water Resources
N.C. State Ports Authority
N.C. Wildlife Resources Commission

Local Agencies

North Carolina Council of Governments Region O
New Hanover County Health Department
New Hanover County Engineer
New Hanover County Planning Department
New Hanover County Building Inspector
Brunswick County Manager
Wilmington Planning Department
Director of Public Works
    City of Wilmington
City Manager
    Southport, N.C.
Town Manager
    Carolina Beach, N.C.
Greater Wilmington Chamber of Commerce
District Conservationist
    Brunswick County
Soil Conservation Service
    Bolivia, N.C.
Soil Conservation Service
    Goldsboro, N.C.
Cama Officer
    Town of Southport
Cama Officer
    Brunswick County
Cama Officer
    Town of Carolina Beach
Cama Officer
    County of New Hanover

Table 13 (continued)

Elected Officials

Hon. Terry Sanford
Hon. Jesse Helms
Hon. Charlie Rose
Hon. R. C. Soles, Jr.
Hon. A. M. Hall
Hon. Harry E. Payne, Jr.
Hon. Tom B. Rabon, Jr.
Hon. Frank Block
Mayor
  Wilmington, N.C.
Mayor
  Carolina Beach, N.C.
Board of New Hanover County Commissioners
Board of Brunswick County Commissioners

Interested Businesses, Groups and Individuals

Star-News Newspapers Inc.
Brunswick Beacon
Shallotte Broadcasting Company
Stateport Pilot
Wilmington-Cape Fear Pilots Association
Harbor Master
  C/O Horton Industries
Southern Wood Piedmont Company
A.S.W. Liquidating Trust
  Marine Midland Bank Trustee
East Coast Terminal, Inc.
Dixie Cement Co., Inc.
Almont Shipping Co.
Pfizer Chemical Co.
Chemserve Terminal, Inc.
Stevedores, Inc.
Koch Sulfur Products Co.
W.R. Grace Co.
Horton Iron and Metal Co.
Delta Marine, Inc.
Wilmington Shipyard, Inc.
Unocal Chemicals
Exxon Company, USA
Mobil Oil Corporation
Shell Island Corporation
Aviation Fuel Terminals, Inc.
Paktank Atlantic Company

Table 13 (continued)

Interested Businesses, Groups and Individuals (continued)

Wilmington Industrial Development Inc.
Bradley Creek 66 Marina Inc.
Wrightsville Marina
Rogers Marine Construction, Inc.
Timber and Land Management Consultants, Inc.
Cape Fear Towing Company, Inc.
Mr. David Weaver
Hanover Towing, Inc.
Stevens Towing, Company
Stone Towing Line
Lavino Shipping Company
Wilmington Shipping Company
Laque Center for Corrosion Technology, Inc.
Southern Bell Telephone and Telegraph Company
Brunswick Electric Membership Corporation
Cape Fear Technical Institute
Dr. James F. Parnell
Mr. A.D. Royal
Mr. William S.R. Beane
Dr. David E. Clapp
Mr. Edmund B. Welch

Libraries

Wilson Library
    Chapel Hill
Librarian
    Department of Natural Resources and Community Development
Randall Library
    UNC-Wilmington
N.C. State Library
New Hanover County Library

8.0 REFERENCES

American Cyanamid Company. 1986. Technical Information, Cythion Insecticide, the Premium Grade Malathion.

Armstrong, D.A., Stevens, B.C., and Hoeman, J.C. 1982. Distribution and Abundance of Dungeness Crab and Crangon Shrimp and Dredging-Related Mortality of Invertebrates and Fish in Gray's Harbor, Washington. Report No. DA-80-86 Washington Department of Fisheries and U.S. Army Corps of Engineers, Seattle District.

Arseneault, J.S. 1981. Dredge Monitoring Program - 1981, Memorandum No. 5902-121-50-2, Field Services Branch, Environment Canada, Vancouver.

Barnard, W.D. 1978. Prediction and Control of Dredged Material Dispersion Around Dredging and Open-Water Pipeline Disposal Operations. Technical Report DS-78-13. US Army Engineer Waterways Experiment Station, August 1978.

Birkhead, W.A., B.J. Copeland, and R.G. Hodson. 1979. Ecological Monitoring in the Lower Cape Fear Estuary, 1971-1976. Report 79-1 to the Carolina Power and Light Company, Raleigh, N.C..

Broome, S.W., E.D. Seneca, and W.W. Woodhouse, Jr. 1981. Planting marsh grasses for erosion control. UNS Sea Grant Publication 81-09. Raleigh, N.C.

Carolina Power and Light Company (CP&L). 1980. Brunswick Steam Electric Plant, Cape Fear Studies: Interpretive Report. Carolina Power and Light Company, Raleigh, N.C..

Carpenter, E.J. 1971. Annual phytoplankton cycle of the Cape Fear River Estuary, North Carolina. Chesapeake Science 12:95-104.

Carriker, M.R., LaSalle, M.W., Mann, R., and Pritchard, D.W. 1986. Entrainment of Oyster Larvae by Hydraulic Cutterhead Dredging Operations: Workshop Conclusions and Recommendations. American Malacological Bulletin, Special Edition No. 3. pp5-10.

Copeland, B.J., R.G. Hodson, and R.J. Monroe. 1979. Larvae and Post Larvae in the Cape Fear Estuary, North Carolina During Operation of the Brunswick Steam Electric Plant, 1974-1978. Report 79-3 to the Carolina Power and Light Company, Raleigh, N.C..

Department of the Army, Waterways Experiment Station. 1984. Shore Protection Manual, Coastal Engineering Research Center.

Hackney, C.T. and G.F. Yelverton. In press. Effects of Human Activities and Sea Level Rise on Wetland Ecosystems in the Cape Fear River Estuary, North Carolina, USA. Junk Publishers, Amsterdam.

Hayes, D.F., G.L. Raymond, and T.N. McLellan. 1984. Sediment Resuspension from Dredging Activities. in Dredging and Dredged Material Disposal. R.L. Montgomery and J.W. Leach, eds. Proceedings of the Conference - Dredging '84. November 14-16, 1984.

Hirsch, N.D., L.H. DiSalvo, and R. Peddicord. 1978. Effects of Dredging and Disposal on Aquatic Organisms. Technical Report DS-78-5. US Army Engineer Waterways Experiment Station, August 1978.

Hodson, R.G., 1979. Utilization of Marsh Habitats as Primary Nursery Areas by Young Fish and Shrimp, Cape Fear Estuary, North Carolina. Report 79-5 to the Carolina Power and Light Company, Raleigh, N.C..

Jones, Edmunds & Associates, Inc. 1979. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment - Access Channels and Anchorage Basins, Military Ocean Terminal - Sunny Point, North Carolina.

Law Engineering Testing Company. 1978. Bottom Sediment and Water Sampling and Analysis, Wilmington Harbor Anchorage Basin, Geo-Environmental Services Division.

Law Engineering Testing Company. 1979. Benthos on the Wilmington Harbor Ocean Bar, North Carolina, Geo-Environmental Services Division.

Lawler, Matusky & Skelly Engineers. 1975. Aquatic Ecology Studies, Cape Fear River Estuary, North Carolina, September 1972 to August 1973. Appendix A of Environmental Impact Assessment of Alternatives for the Maintenance of Wilmington Harbor North Carolina. Report for the U.S Army Corps of Engineers, Wilmington District.

LeGrand, H. E. 1984. Groundwater and its Contamination in North Carolina with Reference to Waste Management. Available from Geo. Science Resources, Burlington, North Carolina.

Lunz, J., D. Clarke, and T. Fredette. 1984. Seasonal restrictions on bucket dredging operations. In: Dredging and Dredged Material Disposal, Proceeding of the Conference, Dredging 1984. ASCE. Montgomery and Leach, editors.

MacNair, C. and G. Banks. 1986. Prediction of Flow Fields Near the Suction of a Cutterhead Dredge. American Malacological Bull. Spec. Ed. No. 3, October 1986. pp. 37-40.

National Waterways Study. 1981. Traffic Forecasting Methodology.

Nichols, P. and E. Louder. 1970. Upstream passage of anadromous fish through navigation locks and use of stream for spawning habitat, Cape Fear River, North Carolina, 1962-1966. US Fish and Wildlife Service, Circ. 252.

North Carolina Department of Human Resources. 1988. Division of Health Services. Risk Evaluation of Malathion Used for Mosquito Control. Memo to Nolan Newton, Vector Control Branch From Environmental Epidemiology Branch.

North Carolina Department of Natural Resources and Community Development. 1986b. Division of Marine Fisheries. Prohibited Area Map, Cape Fear Area. Areas B-1, B-2, B-3, B-4 and A-3.

North Carolina Department of Natural Resources and Community Development. 1989. Division of Environmental Management. Administrative Code 15 NCAC 2B .0311 - Classification and Water Quality Standards Assigned to the Waters of the Cape Fear River Basin.

North Carolina Department of Natural Resources and Community Development. 1986a. Division of Environmental Management. Administrative Code 15 NCAC 2B .0200 - Classification and Water Quality Standards applicable to Surface Waters of North Carolina.

Palermo, M., J. Homziak, and A. Teeter. 1988. Evaluation of Clamshell Dredging and Barge Overflow, Military Ocean Terminal, Sunny Point, N.C. US Army Corps of Engineers Waterway Experiment Station, Vicksburg, MS. for US Army Engineer District, Wilmington, NC. In Preparation.

Payonk, P., M. Palermo, A. Teeter. 1988. Clamshell Dredging and Overflow Monitoring, Military Ocean Terminal, Sunny Point, N.C. in: Proceedings of the American Water Resources Association Symposium on Coastal Water Resources. W. Lyke and T. Hoban eds. May 1988. pp. 95-108.

Peddicord, R.K. and V.A. McFarland. 1978. Effects of Suspended Dredged Material on Aquatic Animals. Technical Report D-78-21. US Army Engineer Waterways Experiment Station, July 1978.

Pezeshki, S. R. and J. L. Chambers. 1986. Effect of soil salinity on stomatal conductance and photosynthesis of green ash (Fraxinus pennsylvanica). Canadian Journal Forest Resources 15:371.

Pezeshki, S. R., R. D. Delaune and W. H. Patrick, Jr. 1987a. Response of bald cypress (Taxodium distichum L. var. distichum) to increases in flooding salinity in Louisiana's Mississippi River deltaic plain. Wetlands 7(1):1-10.

Pezeshki, S. R., R. D. Delaune and W. H. Patrick, Jr. 1987b. Response of freshwater marsh species, Panicum hemitomon, to increased salinity levels. Freshwater Biology 16:569.

Preist, W.I. 1981. The Effects of Dredging Impacts on Water Quality and Estuarine Organisms: A Literature Review. in: A Study of Dredging Effects in Hampton Roads, VA, Final Contract Report for US Army Corps of Engineers, Norfolk District by the Virginia Institute of Marine Science, Walter I. Preist, III ed. March 1981. SRAMSOE No. 247.

Purcell, B.H. 1981. Effects of BTI on Aedes taeniorhynchus and some non-target organisms in the salt marsh.

Purvis, C. 1976. Nursery area survey of Northern Pamlico Sound and tributaries. N.C. Division of Marine Fisheries. Prepared for US National Marine fisheries Service.

Raymond, G.L. 1984. Techniques to Reduce the Sediment Resuspension Caused by Dredging. Miscellaneous Paper HL-84-3. U.S. Army Engineer Waterways Experiment Station, September 1984.

Research Triangle Institute. 1983. Contributions of State Ports to the North Carolina Economy.

Schwartz, F.J., W.T. Hogarth, and M.P. Weinstein. 1981. Marine and Freshwater Fishes of the Cape Fear Estuary, North Carolina and Their Distribution in Relation to Environmental Factors. Brimleyana No. 7:17-37. July 1981.

Sebastien, R.J. and R.A. Brust. 1981. An Evaluation of Two Formulations of Bacillus thuringiensis var. israelensis for Larval Mosquito Control in Sod-lined Simulated Pools. Mosquito News 41:508-511.

Stern, E.M. and W.B. Stickle. 1978. Effect of Turbidity and Suspended Material in Aquatic Environments: Literature Review. Technical Report D-78-21. US Army Engineer Waterways Experiment Station, June 1978.

Struhsaker, P. 1969. Demersal Fish Resources: Composition, Distribution, and Commercial Potential of the Continental Shelf Stocks of the Southeastern United States. US Fish and Wildlife Service, Fish. Ind. Res. 4:261-300.

TEG International, LTD. 1975. Environmental Impact Assessment of Alternatives for The Maintenance of Wilmington Harbor, North Carolina.

U.S. Army Corps of Engineers. 1979. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment, Access Channels and Anchorage Basins, Military Ocean Terminal Sunny Point, N.C.. Unpublished Data Provided by Jones, Edmunds, and Associates, Inc. Under Contract to the Wilmington District. October, 1979.

U.S. Army Corps of Engineers. 1980. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment, Smith Island and Baldhead Shoal Channels, Wilmington Harbor, N.C.. Unpublished Data Provided by Jones, Edmunds, and Associates, Inc. Under Contract to the Wilmington District.

U.S. Army Corps of Engineers, Wilmington District. 1979. Feasibility Report, Wilmington Harbor, Northeast Cape Fear River, Wilmington, North Carolina. February 1979.

U.S. Army Corps of Engineers, Wilmington District. 1982. Environmental Assessment, for Restoration of the Cape Fear River Pelican Islands, New Hanover and Brunswick Counties, North Carolina.

U.S. Army Corps of Engineers, Wilmington District. 1986a. Grain Size Analysis, Chemical Analysis, Bioassay, and Bioaccumulation Potential Analyses for Keg Island Channel Sediments. Unpublished Data, September 1986.

U.S. Army Corps of Engineers, Wilmington District. 1986b. Maintenance Dredging with Clamshell Dredge and Ocean Dumping, Keg Island to Snow Marsh Channels, Wilmington Harbor, North Carolina. Environmental Assessment. November 1986.

U.S. Army Corps of Engineers, Wilmington District. 1989. Wilmington Harbor-Bald Head Island, Wilmington, N.C. Reconnaissance Report, Section 111, PL 90-483. January 1989.

U.S. Army Engineer District, Wilmington. 1967. Carolina Beach and Vicinity, Area South of Carolina Beach, North Carolina, Design Memorandum.

U.S. Army Engineer District, Wilmington. 1971. Fort Fisher and Vicinity, North Carolina - Survey Report of Beach Erosion Control.

U. S. Army Engineer District, Wilmington. 1976. Cape Fear River Bottom Sample, Unpublished analysis of bottom samples.

U.S. Army Engineer District, Wilmington. 1977. Final Environmental Statement-Maintenance of Wilmington Harbor, North Carolina.

U.S. Engineer District, Wilmington. 1980. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment - Smith Island and Bald Head Shoal Channels, Wilmington Harbor, North Carolina.

U.S. Army Engineer, Waterway Experiment Station. 1974. Containment Area Facility Concepts for Dredged Material Separation, Drying, and Rehandling, W. W. Mallory and M. A. Newrocki; Hittman Associates, Inc., Dredged Material Research Program. Contract Report D-74-6.

U.S. Environmental Protection Agency. 1983. Final Environmental Impact Statement, Savannah, Georgia; Charleston, South Carolina; and Wilmington, North Carolina, Ocean Dredged Material Disposal Site Designation. October 1983.

Walburg, C.H. and P.R. Nichols. 1967. Biology and Management of the American Shad and Status of the Fisheries, Atlantic Coast of the United States, 1960. US Fish and Wildlife Service, Spec. Sci. Rpt. Fish. No.550 p35-38.

Weinstein, M.P. 1979. Shallow Marsh Habitats as Primary Nurseries for Fish and Shellfish, Cape Fear River, North Carolina. Fisheries Bull. 77(2)339-357.

Weinstein, M.P., S.L. Weiss, R.G. Hodson, and L.P. Gerry. 1980. Retention of Three Species of Postlarval Fishes in an Intensively Flushed Tidal Estuary, Cape Fear River, North Carolina. Fisheries Bull. 78(2)419-436.

Woodward-Clyde Consultants. 1980. Aquatic and Terrestrial Ecology. Prepared for Brunswick Energy Company.

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APPENDIX A

Long-Term Maintenance of Wilmington Harbor
North Carolina

COMMENTS AND RESPONSES
ON THE
DRAFT ENVIRONMENTAL IMPACT STATEMENT

APPENDIX A

Long-Term Maintenance of Wilmington Harbor
North Carolina

COMMENTS AND RESPONSES
ON THE
DRAFT ENVIRONMENTAL IMPACT STATEMENT

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United States Department of Agriculture

Soil Conservation Service

310 New Bern Avenue
Room 535, Federal Bldg.
Raleigh, NC 27601

April 20, 1988

Colonel Paul W. Woodbury
Corps of Engineers
District Engineer
P. O. Box 1890
Wilmington, NC 28402-1890

Dear Colonel Woodbury:

Because of the extremely heavy workload in implementing the Conservation Provisions of the Food Security Act of 1985, we are unable to provide specific comments the Draft Environmental Impact Statement, Long-Term Maintenance of Wilmington Harbor, New Hanover and Brunswick Counties, North Carolina. Some general comments and recommendations regarding the project are:

1. Work with local units of government to minimize impacts on prime and locally important farmlands.

2. Utilize soil erosion control measures during project construction activities to prevent off-site sedimentation damages.

3. Use locally adapted plants and erosion conservation practices to prevent erosion following project installation.

We regret that we are unable to provide specific comments on your proposed projects relating to soil and water resources in North Carolina. When the conservation provisions of the Food Security Act are implemented, we will again be able to review and provide detailed comments on projects.

Sincerely,

Bobbye J. Jones
State Conservationist

cc: Peter F. Smith, SCS, Washington, DC
James B. Newman, SCS, Washington, DC
Phil Edwards, SCS, Raleigh, NC

United States Department of Agriculture Soil Conservation Service

April 20, 1988

<u>Response</u>:

1. The only upland areas to be impacted by the proposed action are existing dredged material disposal areas; therefore, no farmlands will be affected.

2 and 3. A sedimentation and erosion control plan will be prepared for all land disturbing activities involving one or more acres. The proposed plan will include use of vegetative cover for erosion control.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
OFFICE OF CHARTING AND GEODETIC SERVICES
ROCKVILLE, MARYLAND 20852

MAY 13 1988

MEMORANDUM FOR: David Cottingham
Ecology and Environmental Conservation Office
Office of the Chief Scientist

FROM: for Rear Admiral Wesley V. Hull, NOAA
Director, Charting and Geodetic Services

SUBJECT: DEIS 8804.03 - Long-Term Maintenance of Wilmington Harbor, New Hanover and Brunswick Counties, North Carolina

The subject statement has been reviewed within the areas of Charting and Geodetic Services' (C&GS) responsibility and expertise. Since safety of navigation is one of C&GS' primary missions, this proposal was examined with that in mind and any other impact this maintenance plan may have on C&GS' activities and projects. C&GS considers the maintenance of navigational channels to be extremely important and welcomes any long-range plans to accomplish this mission.

Since all disposal sites are located either in the ocean dredged material disposal site offshore or in diked onshore areas with an estimated 50-year life expectancy, no apparent impact on C&GS activities is apparent. The project area is covered on NOS nautical chart 11537 and, from a chart-making point of view, the proposed project is of minor consequence. Any new information resulting from this activity would be reflected on the chart. If appropriate, the information would be disseminated through chartlets or Notice to Mariners, or both.

Should there be any need for further information about this response, please contact Mr. Erich Frey, Marine Chart Branch, N/CG22x2, WSC1, room 804, Nautical Charting Division, NOAA, Rockville, Maryland 20852, telephone 301-443-8742.

cc:
N/CG17 - Spencer
N/CG22x2 - Frey

75 Years Stimulating America's Progress ★ 1913-1988

United States Department of Commerce May 13, 1988
National Oceanic and Atmospheric Administration
National Ocean Service

<u>Response</u>:

Noted.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9450 Koger Boulevard
St. Petersburg, FL 33702

May 26, 1988 F/SER111/RSS
919/ 728-5090

Colonel Paul W. Woodbury
District Engineer, Wilmington District
Department of the Army, Corps of Engineers
P.O. Box 1890
Wilmington, NC 28402-1890

Dear Colonel Woodbury:

The National Marine Fisheries Service (NMFS) has reviewed Public Notice CESAW-PD-E-88-N-10-65-0005 dated April 11, 1988, whereby the Wilmington District, U.S. Army Corps of Engineers proposes a
1 50-year plan for maintenance dredging in Wilmington Harbor, New Hanover 1
and Brunswick Counties, North Carolina. We have also reviewed the Draft Environmental Impact Statement (DEIS) for this project and have provided comments in a separate letter.

Overall, we find the proposed 50-year maintenance plan to adequately address potential adverse impacts to fishery resources for which we are responsible. However, we are concerned that the plan to mitigate proposed wetland losses is not clearly identified as such in the DEIS and the public notice. The proposed "dike stabilization" plan at disposal
2 areas 11, 12, and 13 would result in a net gain in marsh and thus could 2
offset marsh losses. However, this aspect of the project may be subject to deletion if future funding is limited. Therefore, we recommend that the project plans be revised to clearly state the Corps' intended multiple objective of dike stabilization and mitigation for proposed marsh losses. This action would lend assurance to both approval and funding of this necessary aspect of the project.

If we can be of further assistance in this matter, please advise.

Sincerely yours,

for Randall P. Cheek

Andreas Mager, Jr.
Acting Assistant Regional Director
Habitat Conservation Division

United States Department of Commerce May 26, 1988
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Regional Office

Response:

1. Noted.

2. Even though the dike stabilization plan/dike and shoreline erosion control plan would create more marsh than it would eliminate, this plan is an integral part of project planning and design, not mitigation. The plan is the most economical method to prevent the loss of disposal capacity over the 50 year planning period. Therefore, this erosion control plan in not a separable component of the overall long-term maintenance plan and will not be deleted.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9450 Koger Boulevard
St. Petersburg, FL 33702

May 31, 1988 F/SER111/RSS
919/728-5090

Colonel Paul W. Woodbury
District Engineer, Wilmington District
Department of the Army, Corps of Engineers
P.O. Box 1890
Wilmington, NC 28402-1890

Dear Colonel Woodbury:

Please reference your March 29, 1988, letter requesting our comments on the Draft Environmental Impact Statement (DEIS), Long-Term Maintenance Dredging of Wilmington Harbor, New Hanover and Brunswick Counties, North Carolina. The National Marine Fisheries Service has reviewed the subject document and offers the following comments for your consideration.

General Comments

In our opinion, resources for which we are responsible and this project's potential adverse impacts on these resources are generally addressed to our satisfaction in the DEIS. However, we are concerned that wetland losses associated with dike construction in disposal areas 11, 12, and 13 may not be replaced if future funding constraints were to eliminate the planned "dike stabilization" using transplanted marsh. Accordingly, we recommend that the Final Environmental Impact Statement include a firm commitment to the proposed marsh construction activity not only for the purpose of stabilizing newly constructed dikes, but also as clearly stated mitigation for proposed wetland losses.

Specific Comments

Section 3.6.3 Controlling Erosion on Existing Disposal Islands

Page 73, paragraph 2. This section addresssed the "dike stabilization" plans outlined in Section 3.2.2; however, it does not directly address mitigation for the proposed wetland losses. We recommend that a paragraph be added to this section that outlines the Wilmington District's commitment to mitigating the wetland losses incurred at disposal areas 11, 12, and 13 as an intregal part of the overall project, not necessarily linked to funding for dike stabilization.

Thank you for the opportunity to provide these comments.

Sincerely yours,

Andreas Mager, Jr.
Acting Assistant Regional Director
Habitat Conservation Division

United States Department of Commerce May 31, 1988
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Regional Office

Response:

See response to the May 26, 1988 United States Department of Commerce letter.

United States Department of the Interior

OFFICE OF ENVIRONMENTAL PROJECT REVIEW
RICHARD B. RUSSELL FEDERAL BUILDING, SUITE 1320
75 SPRING STREET, S.W.
ATLANTA, GEORGIA 30303

TAKE PRIDE IN AMERICA

ER-88/226

JUN 2 1988

Colonel Paul W. Woodbury
District Engineer
U.S. Army Corps of Engineers
Post Office Box 1890
Wilmington, North Carolina 28402

Dear Colonel Woodbury:

We have reviewed the draft environmental statement for Long-Term Maintenance of Wilmington Harbor, New Hanover and Brunswick Counties, North Carolina, and have the following comments.

General Comments

The document adequately describes the project area's resources of interest
to the U.S. Fish and Wildlife Service (Service). Although the document
1 outlined most of the direct environmental impacts of the proposed project,
additional information is required to assess potential adverse impacts 1
associated with the use of mosquito larvicides. This includes potential
adverse impacts to federally-listed threatened and endangered species.

Specific Comments

Section 4.2.2.2.; page 54: The discussion of the habitat values of
disposal site No. 18 should be expanded. The site's forested uplands
contain pools, shrub thickets, and an abundance of soft and hard mast
producing trees. Small, isolated wetlands, such as the ephemeral pools,
2 are biologically important systems that support species that normally 2
cannot avoid predators or compete with species found in larger systems.
Many amphibians that require aquatic habitats for only a portion of their
life history are able to exploit the habitat provided by ephemeral pools
(P.E. Moler and R. Franz 1988). In turn, these amphibians may become prey
items for wading birds and terrestrial vertebrates.

Forested wetlands, such as those that occur on site No. 18, typically
provide high quality habitat for a wide variety of wildlife species,
3 including opossum (Didelphis marsupialis), raccoon (Procyon lotor), marsh 3
rabbit (Sylvilagus palustris), reptiles and amphibians. These habitats
generally support abundant and diverse bird populations and may be
important nesting and foraging sites for migratory neotropical songbirds.

Section 4.3; page 57: Change "rough-leafed loosestrife" to read "rough-
4 leaved loosestrife". 4

Section 4.3; page 56: Although many pesticides may be registered for use by the Environmental Protection Agency (Agency), presently, either: (1) potential impacts to listed species have not been assessed by the Agency and consultation, as required under Section 7 of the Endangered Species
5 Act, has not been conducted; or (2) the reasonable and prudent measures or 5
alternatives recommended in a biological opinion have not been implemented. Therefore, the document should assess the potential for adverse impacts to listed species from the potential use of mosquito larvicides on dredged material disposal sites.

Section 5.2.2.2.; page 72: Although pesticides may be registered for use by the Agency, the document should list the pesticides used for mosquito
6 control and assess the impacts to non-target fauna from application to 6
dredged material disposal sites.

Summary Comments

The development of a long-term plan for dredged material disposal in the Wilmington Harbor is an important step toward minimization of adverse environmental impacts from harbor dredging activities. We commend the
7 Corps for the planned shoreline grading and stabilization with plantings of 7
intertidal marsh vegetation at disposal sites No. 11, 12, and 13 as mitigation for wetlands loss within these sites.

However, the Service continues to object to the use of disposal site No. 18 for dredged material disposal as outlined in a October 7, 1987, scoping report. Since dredged material disposal at this location would eliminate an existing high quality habitat for resident and migratory wildlife, we
8 recommend against the use of this site. Alternatively, we recommend use of 8
the existing Point Peter disposal site located approximately 2 miles from site No. 18. The adverse impacts to non-target species, including endangered species, from use of mosquito larvicides on dredged material disposal sites, should be assessed and documented in the Final Statement.

We appreciate the opportunity to provide these comments.

Sincerely yours,

James H. Lee

James H. Lee
Regional Environmental Officer

United States Department of the Interior June 2, 1988
Office of Environmental Project Review

Response:

1. Sections 5.2.2.2 and 5.3 of the final EIS addresses these comments.

2 and 3. Section 4.2.2.2 of the final EIS has been modified to reflect that site 18 is also used by small mammals, reptiles and amphibians. Due to its isolation from adjacent woodlands the habitat potential of site 18 is atypical and therefore reduced. As stated in section 4.2.2.2 of the EIS, the habitat structure and diversity in the site is good but little evidence of actual use by deer or medium-sized mammals was noted during field investigations.

4. This change has been made.

5 and 6. See response to 1 above.

7. Noted. However, the planting of marsh grass for erosion control on islands 11-13 is not mitigation, this planting is an integral part of project planning and design.

8. Site 18 was selected because other sites in the area were either cost prohibitive or would have even greater environmental losses associated with their use. Site 18 was also considered the best site for use because of its relative isolation from other forested habitats and previous history of dredged material disposal.

The Point Peter disposal site (16) will be used as part of the long-term maintenance of Wilmington Harbor. However, site 16 alone is not adequate for the long-term maintenance needs of the entire upper harbor; therefore, site 18 is needed too.

See response to 1 above regarding larvicides.

U.S. Department of Housing and Urban Development
Atlanta Regional Office, Region IV
Richard B Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303-3388

June 2, 1988 PD-E

Colonel Paul W. Woodbury
District Engineer, Corps of Engineers
Wilmington District
Wilmington, North Carolina 28402-1890

Dear Colonel Woodbury:

We have reviewed the Draft Environmental Impact Statement for the Long-Term Maintenance of Wilmington Harbor, New Hanover and Brunswick Counties, North Carolina.

Based upon our review, it does not appear that the project will have any adverse impacts on the Housing and Urban Development activities in the project vicinity.

We appreciate the opportunity for review and comment. If we may be of additional assistance, please contact us at FTS 242-3167.

Sincerely,

for Clara J. DeLay
Regional Environmental Specialist

United States Department of Housing and Urban Development
Region IV

June 2, 1988

Response:

Noted.

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
Atlanta GA 30333

June 7, 1988

Frank Yelverton
Environmental Resources Branch
U.S. Army Engineer District
Wilmington
P.O. Box 1890
Wilmington, North Carolina 28402-1890

Dear Mr. Yelverton:

Thank your for sending the Draft Environmental Impact Statement (DEIS) for "The Long-Term Maintenance of Wilmington Harbor, New Hanover and Brunswick Counties, North Carolina." We are responding on behalf of the U.S. Public Health Service. We have reviewed the document and have no comments to offer at this time.

Thank you for sending this document for our review. Please insure that we are included on your mailing list for further documents which are developed under the National Environmental Policy Act (NEPA).

Sincerely yours,

David E. Clapp

David E. Clapp, Ph.D., P.E.
Environmental Health Scientist
Special Programs Group
Center for Environmental Health
and Injury Control

United States Department of Health and Human Services
Centers for Disease Control

June 7, 1988

Response:

Noted.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET
ATLANTA, GEORGIA 30365

JUN 10 1988

4PM-EA/GJM

Colonel Paul W. Woodbury
District Engineer
U.S. Army Corps of Engineers
Wilmington District
P.O. Box 1890
Wilmington, North Carolina 28402-1890

SUBJECT: Draft Environmental Impact Statement (DEIS), Long-Term Maintenance of Wilmington Harbor, New Hanover and Brunswick Counties, North Carolina; ERP No.: D-COE-E32067-NC

Dear Colonel Woodbury:

Pursuant to Section 309 of the Clean Air Act and Section 102(C) of the
National Environmental Policy Act, EPA, Region IV has reviewed the subject
document. Prior to this evaluation a member of my technical staff parti-
1 cipated in a scoping meeting (July 19, 1985) to delineate the significant 1
environmental issues associated with or resulting from this proposal.
Subsequent coordination/discussions with other Federal and state resource
agencies as well as two on-site investigations with District biologists
have continued throughout preparation of the DEIS.

In large measure the issues we raised and suggestions which were made
during this dialogue have been incorporated in the text. While this will
be a relatively large and ongoing undertaking, the environmental ramifica-
tions of the harbor maintenance which are within EPA's sphere of interest
are within acceptable limits. However, this appraisal is based on the compre-
hensive structural measures necessary to meet project objectives rather
than an absolute assessment. That is, while the adverse consequences of
2 this action are not considered significant and no mitigation is planned, 2
the cumulative environmental impacts of this and other similar activities
within this area will have to be considered during the project life. We
anticipate that the project will undergo any number of modifications
during its 50 year life span. As these changes are made we intend to
work closely with the District's technical staff to ensure that the
environmental aspects of these alterations are satisfactorily addressed
together with the more complicated matter of mitigating cumulative/induced
effects.

As a result of our review, a rating of LO has been assigned. That is,
3 EPA does not have any significant environmental objections to the proposal 3
as it is currently described. If we can be of any further assistance,
please call Dr. Gerald Miller of my staff at 404/347-3776 or FTS 257-3776.

Sincerely yours,

Sheppard N. Moore

Sheppard N. Moore, Chief
NEPA Review Staff
Environmental Assessment Branch

United States Environmental Protection Agency June 10, 1988
Region IV

<u>Response</u>:

1. Noted.

2. These concerns will be addressed during the periodic review that will occur every 5 years (section 3.6.5).

3. Noted.

North Carolina Department of Human Resources
Division of Health Services
P.O. Box 2091 • Raleigh, North Carolina 27602-2091

James G. Martin, Governor
David T. Flaherty, Secretary

Dr. Alice L. Anderson
Medical Entomologist
NC Division of Health Services
NC Aquarium
Atlantic Beach, NC 28512
Phone (919) 247-4003

Ronald H. Levine, M.D., M.P.H.
State Health Director

April 14

MEMO

TO: Linda Sewell

FROM: Alice L. Anderson

I have some comments regarding the Draft Environmental Impact Statement on Long-Term Maintenance of Wilmington Harbor, North Carolina, page 72, section 5.2.2.2 Fauna.

First, the species of mosquitoes which are produced on dredged spoil habitats (primarily *Aedes sollicitans* and *Aedes taeniorhynchus*) can and do travel from 4 to 40 miles in search of a blood meal. "Remote" spoil sites are therefore still potential "severe nuisances". If a strong wind blowing from the spoil site to the inhabited area occurs at any time after the hatch until the end of the summer season, there is a good chance that the population of mosquitoes produced even in "remote" areas will become a severe nuisance in the heavily populated areas of the city. Since these mosquitoes can transmit dog heartworm and Eastern equine encephalitis, they are a health threat.

Further, the EIS s[illegible] that outbreaks in the past have been controlled by aeri[illegible] [illegible]plication of larvicide. In discussing this with local mosquito control personnel, I have learned that the larvaciding action was only taken after the public complaint level had reached a VERY high level. The public complaints were a result of ADULT mosquito problems, so that larvaciding had little effect on the problem after the fact.

Our research shows that salt marsh areas produce from one to two broods of mosquitoes per month in the Southern part of the Coastal area. If these populations are left untreated and continue to breed until the public complaint level reaches VERY high levels, larvaciding at the end of the season will be only of limited success if any, since the adult population is already very high. If the TOTAL population is not MONITORED and CONTROLLED throughout the summer, the fall population has built up to almost unmanageable porportions, especially with the proposed "as needed" treatment as experienced in the past.

This document does not define how the "as needed" times will be determined, does not state who will be responsible for the surveillance needed to FIND the larvae so that they can be treated effectively, nor does it state who will be responsible for the cost of this work.

It is my recommendation that an agreement be drawn up between the mosquito control division in New Hanover County and the Wilmington District Corps of Engineers to provide a thorough surveillance and treatment program for the spoil sites proposed in this plan. Other states have excellent cooperation with the Corps on the same problem (Savannah GA, for example).

Without a responsible attitude from the Corps of Engineers concerning this ongoing problem, I must say that the EIS has tried to brush aside a serious, well acknowledged problem with a superficial statement.

North Carolina Department of Human Resources
Division of Health Services

April 14, 1988

Response:

Section 5.2.2.2 of the final EIS addresses these comments.

DIVISION OF WATER RESOURCES

May 9, 1988

MEMORANDUM

TO: Melba McGee

FROM: John D. Sutherland

SUBJECT: Review of Draft EIS for the Long-Term Maintenance of Wilmington Harbor

This Draft Environmental Impact Statement adequately describes the environmental consequences of the long-term maintenance plan for the navigation channels in Wilmington Harbors.

bb
cc: Mr. John N. Morris

Response:

Noted.

DIVISION OF ENVIRONMENTAL MANAGEMENT

May 12, 1988

M E M O R A N D U M

TO: Melba McGee
Planning & Assessment

FROM: Bill Mills
Water Quality Section

SUBJECT: Draft EIS
Long-Term Maintenance of Wilmington Harbor
U.S. Army Corps of Engineers

There are two aspects of the proposed maintenance plan which are not adequately addressed in the Subject document:

1. The proposed discharges from the operation of barge overflows have not been adequately described and evaluated with respect to the effects on Water Quality Standards. The results of the 1987 Barge Overflow Project at MOTSU should be included and used in projecting turbidity impacts. A 401 Water Quality Certification for discharges from barge overflow on the Subject project was received on April 20 and is under evaluation.

2. The changes in wetland vegetation caused by saltwater intrusion into the once freshwater wetlands bordering the Cape Fear Estuary, and that the majority of these changes seem associated with deepening and widening of the Cape Fear River Channel (Hackney, 1987).

BM/dkb

cc: Preston Howard

North Carolina Division of Environmental Management
Water Quality Section

May 12, 1988

Response:

1. Section 5.1.4.2 of the final EIS addresses these comments.

2. Sections 4.1.4.2 and 5.1.4.2 of the final EIS addresses these comments.

North Carolina Wildlife Resources Commission

512 N. Salisbury Street, Raleigh, North Carolina 27611, 919-733-3391
Charles R. Fullwood, Executive Director

May 13, 1988

MEMORANDUM

TO: Melba McGee, Planning and Assessment
Dept. of Natural Resources & Comm. Dev.

FROM: Richard B. Hamilton *Richard B. Hamilton*
Assistant Director

SUBJECT: STATE CLEARINGHOUSE A95/EIS PROJECT NUMBER 88-0846: Draft Environmental Impact Statement---Long-Term Maintenance of Wilmington Harbor North Carolina, New Hanover and Brunswick Counties, North Carolina

The Wildlife Resources Commission has reviewed the subject Draft Environmental Impact Statement (DEIS) and professional biologists on our staff are familiar with habitat values of the project area. Although we have been unable to conduct an onsite investigation due to time and staff constraints, we believe that sufficient information is available to warrant certain comments. In addition we have
A met with the Corps of Engineers with regards to the subject A
project during the scoping process for the subject project. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the North Carolina Environmental Policy Act (G.S. 113A-1 et seq., as amended; 1 NCAC 25), and the Coastal Area Management Act (G.S. 113A-100 through 113A-128).

Overall the document is well written and provides a thorough discussion of most areas of concern. Document preparers should be commended for a job well done. However,
B we believe certain additional information or clarification B
must be considered in preparation of the final document. The following general comments reflect major concerns:

1. Section 3.2.2 (pg. 14-15) states that erosion protection will be provided for disposal area dikes

in the form of grading shorelines to 3% and establishing a marsh border. Section 3.6.3 (pg. 20-21) states that the same erosion protection measures at six sites is not feasible. The transition between pages is not clear and needs additional clarification.

2. We believe that the DEIS should contain more inherent flexibility in utilizing dredged material for management or creation of colonial bird nesting habitat. Section 3.6.2 is very restrictive with regards to future needs as coastal development continues to degrade other nesting areas and will probably do so over the next 50 years at an even greater rate. We believe that re-writing the section to retain more flexibility is not only essential for sound management of wildlife resources, but is also in the best interests of the Corps of Engineers and local sponsors. As written, we find the section unacceptable.

3. We disagree with the contention that 32 acres of non-wetland habitat at Disposal Site 18 is not a significant resource (Section 5.2.4, pg. 73). Based upon the description provided in the DEIS and a previous site visit, we believe that such a loss of habitat is significant and cannot go unnoticed. Coastal development in general has devastated wildlife habitat along practically all of North Carolina's coastline. The individual and cumulative effect of losing an additional 32 acres of relatively high quality habitat will only exacerbate the overall problems of coastal wildlife resources and the quality of the natural environment. We recommend that Disposal Site 18 be deleted from further consideration for use in long term maintenance of Wilmington Harbor and that the area be permanently protected through public ownership or conservation easement. Loss in disposal capacity can be compensated by utilizing Disposal Sites 17 and 19 due to their relatively close proximity. If necessary, these sites could be expanded to receive additional volumes that would have been placed in Site 18.

4. The DEIS does not address cumulative impacts (direct and indirect) sufficiently, especially when considering ongoing and planned projects such as expansion of the Wilmington Harbor-Northeast Cape Fear River proposal. All direct impacts resulting from past activities, expansion of existing facilities, planned expansion, and new construction being considered should be thoroughly discussed. In addition, the DEIS must address indirect impacts

such as enhancement of riparian habitat for further industrial, residential, and urban development. Such an assessment must consider potential impacts from private entities with potential for study area limits.

Thank you for the opportunity to review and comment on this application. If our comments need clarification of if we can provide further assistance, please call on us.

RBH/lp

cc: Mrs. L. K. (Mike) Gantt, USFWS
Mr. Dennis Stewart

North Carolina Wildlife Resources Commission May 13, 1988

Response:

A and B. Noted.

1. Agreed. Section 3.6.3 of the final EIS addresses these comments.

2. We disagree that our proposed plans for managing colonially nesting waterbirds in the river are in need of greater flexibility. We are committed to the management of existing islands in the river and have completed management actions on them in the past. However, we are not currently in a position to recommend creating new islands as they are not required for dredged material disposal and the costs to the estuarine system are potentially high. As stated in the EIS (section 3.6.2), if other agencies or interests obtain all necessary environmental clearances and perform any necessary site preparation, the District will provide the dredged material to create the island and will maintain it in conjunction with future maintenance dredging.

3. The determination of significance of site 18 was based on an evaluation of many parameters including presence of wetlands, habitat diversity, wildlife utilization, size of the tract, regional context, availability of similar habitats in the area, and past use as a disposal site. In weighing these factors, it was determined that site 18 was not a significant resource primarily due to its isolation (with subsequently lower wildlife values), availability of abundant higher quality wildlife habitat nearby, and the sites prior use as a dredged material disposal area. Therefore we can not justify the purchase of these lands for conservation purposes.

Site 17 is only 10 acres and is filled with dredged material. The upland portion of site 19 is only 12 acres. Even if site 17 was not full, the combined capacity of sites 17 and 19, 22 acres, would be 6 acres less than the long-term capacity needs that site 18 provides. Sites 17 and 19 can not be feasibly expanded since they are surrounded by wetlands.

4. We disagree. The EIS adequately addresses the direct and indirect impacts of the proposed action. The long-term project just involves maintenance of existing channel dimensions and use of previously used disposal areas. Since no harbor expansion is proposed under this action, a change in forecasted growth trends for the port of Wilmington is not anticipated.

All disposal areas will be owned in fee simple by the state, county or the Corps of Engineers which will preclude development or any use other than the disposal of dredged material. Therefore, no significant impacts to existing resources are anticipated.

Section 3.8 of the EIS describes anticipated harbor expansion. The impacts, including cumulative impacts, of these actions will be discussed in the NEPA documents required for each proposed expansion project. A discussion of the cumulative impacts of these expansions is not appropriate in the long-term EIS since the long-term maintenance of Wilmington Harbor is not dependent on any of the expansion projects being constructed.

APPENDIX B

Long-Term Maintenance of Wilmington Harbor
North Carolina

BEACH AND OFFSHORE DISPOSAL ALTERNATIVES

APPENDIX B

Long-Term Maintenance of Wilmington Harbor
North Carolina

BEACH AND OFFSHORE DISPOSAL ALTERNATIVES

Beach Disposal Alternative. The grain size characteristics of the shoal material in the various reaches of the Wilmington Harbor ship channel were evaluated in order to determine the location of shoal material that would be suitable for placement on nearby beaches by pipeline dredge. This evaluation identified several areas that had suitable material and alternative procedures for placing this material on the beach were investigated.

Shoal Material Size Characteristics. The Wilmington Harbor ship channel extends about 27 miles from deep water in the ocean off the mouth of the Cape Fear River estuary to an anchorage basin at Wilmington. This channel is divided into 21 reaches plus the anchorage basin and approach channel as shown on figure 1. Table B1 lists each of the channel reaches and the average quantity of shoal material removed each year. Under present maintenance procedures, material removed from the Battery Island range seaward to and including the Baldhead Shoal range is deposited in an ocean disposal area by hopper dredge while the other reaches are maintained by pipeline dredge using island disposal areas.

The size characteristics of the ship channel bottom material were determined from samples collected and analyzed in association with other studies of Wilmington Harbor (US Army Engineer District, Wilmington 1976, 1977, and 1980; TEC 1975; Law Engineering Testing Company 1978 and 1979; Jones, Edmunds and Associates, Inc. 1979). The location of the sample points are shown on figure B1 while the mean particle size and the standard deviation of the samples, expressed in phi units, are given in table B2. Based on the size characteristics of these samples, the channel bottom material downstream of Wilmington appears to be divided into four major zones, namely: (1) the ocean bar channel seaward of buoy number 4 which consists primarily of silt and sandy silt; (2) buoy number 4 to and including Reaves Point Channel which is composed of sandy material; (3) Lower Midnight Channel to Upper Brunswick Channel which contains a mixture of sand and silt; and (4) the Fourth East Jetty Channel to the Anchorage Basin, which is comprised of silt and some sandy silt. Because of the sand characteristics, the only section of the channel that could be maintained by placing the shoal material on the beach is that portion from buoy number 4 to Reaves Point channel. Hopper dredging and offshore disposal is presently used in the segment of the channel seaward of the Battery Island Range, and this maintenance practice is expected to continue in the future. Therefore, only the section of the channel between the Lower Swash and Reaves Point ranges was considered for possible beach disposal. The total average annual volume of shoal material removed from this segment of the ship channel is 101,000 cubic yards of which 12,000 cubic yards is removed from the Lower Swash range, 17,000 cubic yards from the Snow Marsh range, 47,000 cubic yards from the Horseshoe Shoal range, and 25,000 cubic yards from the Reaves Point range.

Alternatives Considered. In developing the beach disposal alternative, two beach disposal sites were evaluated, namely: (1) the shoreline fronting the Fort Fisher State Historic Site and (2) the Town of Kure Beach shoreline. In addition, two methods of depositing the material on the beach were considered and were: (1) temporarily storing the material during annual maintenance operations and pumping to the beach on a periodic basis and (2) pumping the material directly to the beach during each maintenance operation. These alternatives have been given the following designation:

A1 - Temporary storage with disposal on Fort Fisher
A2 - Temporary storage with disposal on Kure Beach
B1 - Direct disposal on Fort Fisher
B2 - Direct disposal on Kure Beach

Due to the extremely long pumping distance from the Lower Swash range to the beach disposal sites or to a temporary storage area and the relatively small quantity of material removed from this range, the Lower Swash range was not included in the beach disposal alternative evaluation. For these same reasons, the lower portion of the Snow Marsh range was also excluded. The volume of material that would be available for placement on the beach from the remaining ranges; which includes Reaves Point, Horseshoe Shoal, and the upper portion of Snow Marsh is estimated to be about 89,000 cubic yards/year. Of this total, 25,000 cubic yards/year would be obtained form the Reaves Point range, 47,000 cubic yards/year from Horseshoe Shoal, and 17,000 cubic yards/year from the upper portion of Snow Marsh.

Comparison of Shoal Material Size Characteristics with Native Beach Material on Kure Beach and Fort Fisher. The composite size characteristics of the shoal material in the Reaves Point to Snow Marsh channel ranges was determined from the information given in table B2. The shoal material was found to have a mean size of 2.0 phi (0.25 mm) and a standard deviation of 1.38 phi (0.28 mm). The size characteristics of native beach sand on Kure Beach and Fort Fisher was computed from samples collected from five ranges, two on Kure Beach and 3 on Fort Fisher. Each of these ranges were sampled from the crest of the berm seaward to the 30-foot depth contour in 2-foot depth intervals. Information on the Kure Beach and Fort Fisher samples are given in US Army Engineer District, Wilmington (1967, 1971).

A preliminary comparison of the two native beach sands indicated that both beaches have essentially the same characteristics. Accordingly, the five sample ranges were used to compute a composite size distribution for the native beach sand which is applicable for both Kure Beach and Fort Fisher. The resulting composite distribution for the beach material had a mean of 1.66 phi (.32 mm) and a standard deviation of 1.00 phi (0.24 mm). The suitability of the shoal material as a source of beach nourishment was determined in accordance with the procedures outlined in Department of the Army (1984). The suitability analysis indicated that the shoal material has an overfill factor of 1.4 which means that 1.4 cubic yards of shoal material will have to be placed on the beach in order to yield 1 cubic yard of sorted beach sand. In addition, the renourishment factor, which is a measure of the expected performance of the fill material compared to the native beach sand, is 1.0 indicating that the erosion losses from the fill following sorting will be about the natural rate. Thus, the shoal material is an acceptable source of beach fill material.

Pipeline Route. The proposed overland pipeline route that would be used to transport the material to the beach disposal areas comes ashore near the Southport-Fort Fisher ferry terminal and follows U.S. Highway 421. This proposed route is shown on figure B2. The average length of the shore pipeline to the Fort Fisher and Kure Beach disposal sites is 10,000 feet and 16,500 feet, respectively. The total pumping distances range from 21,000 to 25,000 feet.

Temporary Storage Area. Disposal Area 4 which is located as shown on figure 1, would be used as a temporary storage area for the alternatives involving periodic beach disposal. This disposal area has a total surface area of 21 acres and is ringed by a dike constructed to an elevation of 22 feet above m.l.w.. The volume of material that would have to be stored depends on the frequency of the beach disposal operations. Accordingly, the temporary storage/beach disposal alternatives were developed on the basis of a 10-year beach disposal cycle. Since the material removed from the channel ranges during the 10th year of the cycle would be pumped directly to the shoreline, the temporary storage area was designed to contain 801,000 cubic yards or 9 years of maintenance material.

In order to accommodate this quantity of material, the sand presently stored in Disposal Area 4 would be excavated and pumped to the beach. If the assumption is made that a 27-inch pipeline dredge with a minimum digging depth of 20 feet below m.l.w. is used for this initial excavation, 15.7 acres, or 75%, of Disposal Area 4 would be removed. The area to be dredged contains a total volume of 860,000 cubic yards. In addition, an access channel would have to be dredged from the ship channel to Disposal Area 4 which would increase the initial dredge volume by 65,000 cubic yards. Thus, the total volume of material to be initially dredged to develop the temporary storage area would be 925,000 cubic yards.

The adequacy of the temporary storage area to remove solids from the dredge discharge was based on an average flow rate of a 27-inch pipeline dredge of 47.6 cfs and a surface area of the temporary storage area of 682,700 ft2 (15.7 acres). According to US Army Engineer (1974), the area is adequate to remove particles as small as .018 mm. Since the composite distribution of the sand in the three channel reaches does not contain material this fine, the temporary storage area would be able to remove essentially all of the solids in the dredge discharge.

Alternative A1. Material removed during the initial excavation of Disposal Area 4 to create the temporary storage area would be placed along 8,000 feet of shoreline fronting the Fort Fisher State Historic Site as shown on figure B2. Allowing for 15% losses from the fill during placement and the 29% sorting losses expected due to the difference in the fill and native beach sand characteristics, the initial deposition of material from Disposal Area 4 would widen the beach by an average of 48 feet. Historic erosion of the shoreline in front of Fort Fisher has been extremely high, varying from approximately 11 feet/year in the vicinity of the existing rubble revetment to around 6 feet/year south of the revetment. For the entire 8,000-foot beach segment, the average rate of erosion since 1938 has been 7.7 feet/year which is equivalent to a volumetric loss of 70,000 cubic yards/year. During each 10-year beach disposal operation, a total of 890,000 cubic yards of material would be placed on the shoreline. Assuming that 44% of this material would also be lost during initial placement and by sorting, the net quantity of material placed on the beach would average 50,000 cubic yards/year. It appears therefore, that the erosion rate at Fort Fisher would be reduced by 70%.

The equivalent average annual cost of Alternative A1 was computed for a 50-year amortization period at an interest rate of 8-7/8%. In all, there are three different operations involved in the alternative, namely: (1) initial excavation of Disposal Area 4 with placement on the Fort Fisher shoreline; (2) temporary storage of the material removed from the channel ranges during a 9-year period; and (3) beach disposal from the temporary storage area and the channel ranges every 10 years. The costs of each of these three operations are given in table B3. The equivalent average annual cost of each operation and the total average annual cost of Alternative A1 are given in table B4.

<u>Alternative A2</u>. The material removed from Disposal Area 4 during initial excavation would be distributed along 13,000 feet of shoreline in front of the Town of Kure Beach. The net inplace fill volume obtained from this source would widen the beach by 30 feet. The historic erosion rate along this 13,000-foot beach segment has averaged 4.2 feet/year since 1938 which is equivalent to a volumetric loss of about 62,000 cubic yards/year. The 10-year disposal cycle on Kure Beach would also result in an average nourishment rate of 50,000 cubic yards/year which would reduce the erosion rate by 80%.

The operations involved with this alternative are the same as the three operations associated with Alternative A1 with the only difference being the longer pumping distances to Kure Beach. The cost of the three separate operations are given in table B5 while the average annual equivalent cost computed over a 50-year period at an interest rate of 8-7/8% is given in table B6.

<u>Alternatives B1 and B2</u>. Alternatives B1 and B2 which would involve the direct disposal of the shoal material on the beaches during each biennial maintenance operation, would not produce any effective widening of the respective beaches. Due to the relatively small quantity of material (178,000 gross cubic yards or 100,000 net cubic yards), disposition on the beach would be in the form of a 1,000-foot-long feeder beach. Generally, the feeder beach would be placed at the updrift or north end of the beach; however, if problems developed at specific sites, the disposal location could be varied accordingly.

The annual cost of these two alternatives are given in tables B7 and B8 for Fort Fisher and Kure Beach, respectively. In computing the cost of the alternatives, the assumption was made that an 18-inch pipeline dredge would normally perform maintenance dredging in the upper portion of Wilmington Harbor, i.e., from the Fourth East Jetty channel north, and that this dredge would be moved to the Reaves Point-Snow Marsh area to transfer material to the beach. The 18-inch dredge would need the assistance of two booster pumps in order to place the material on either Fort Fisher or Kure Beach.

Discussion of Alternatives. The average annual costs of the alternatives are presented in table B9. The cost for bucket and barge dredging is based on semi annual dredging with a unit cost of $2.40 per cubic yard and a discount rate of 8 7/8%. The costs for direct beach disposal are 18 to 31% less than the temporary storage alternatives. However, the average annual cost for bucket and barge dredging of $205,000 is 63 to 73% less than direct beach disposal.

Ocean disposal by Pipeline. This alternative assumes that material removed from Lower Lilliput to Lower Swash range is pumped to a point near Fort Fisher. Pumping distances, material characteristics and quantities are contained in table B10.

The costs in table B11 are just for pumping the material to the beach and do not include the cost of pumping the material 5,000 feet offshore for disposal. However, the partial cost is enough to make this alternative economically infeasible when compared to the cost shown in table B12 for bucket and barge dredging with ocean disposal.

TABLE B1

Estimated Annual Volume of Maintenance Dredging by Reach

Annual Average Volume Maintenance Dredge Material (Cu Yds)	Channel Reach
820,000	Baldhead Shoal, Smith Island, Caswell-Southport, Southport, Battery Island
12,000	Lower Swash
17,000	Snow Marsh
47,000	Horseshoe Shoal
25,000	Reaves Point
26,000	Lower Midnight
118,000	Upper Midnight
45,000	Lower Lilliput
49,000	Upper Lilliput
29,000	Keg Island
8,000	Lower Big Island
3,000	Upper Big Island
31,000	Lower Brunswick
19,500	Upper Brunswick
26,000	Fourth East Jetty
50,000	Between Channel
930,000	Anchorage Basin and Approach
17,500	32' project
10,000	25' project
2,283,000	Total

TABLE B2

Size Characteristics of Ship Channel Bottom Material

Range	Sample *	Mean Size Mo Phi	(mm)	Standard Deviation So Phi	(mm)
Baldhead Shoal	(Seaward Buoy #4)		Silt		
	Buoy #4 to Buoy #13	1.652 **	(0.32)	1.082 **	(0.26)
Southport	1977 EIS #1	1.24	(0.42)	1.09	(0.35)
Lower Swash	1976 #4	-0.61	(1.53)	0.35	(0.37)
Snow Marsh	1976 #5	1.83	(0.28)	0.43	(0.09)
	1977 EIS #2	2.72	(0.15)	0.47	(0.05)
	1976 #7	1.35	(0.39)	0.84	(0.24)
Horseshoe Shoal	1977 EIS #3	1.63	(0.32	0.84	(0.20)
	1976 #8	0.97	(0.51)	0.97	(0.37)
Reaves Point	1976 #10A	1.93	(0.26)	0.64	(0.12)
Lower Midnight	1976 #13	3.49	(0.09)	0.93	(0.93)
Upper Midnight	1977 EIS #4	4.34	(0.05)	0.94	(0.03)
	1976 #18	1.67	(0.31)	0.27	(0.06)
	1977 EIS #5	5.59	(0.02)	1.41	(0.02)
Lower Lilliput	1976 #20	2.13	(0.23)	0.62	(0.10)
Upper Lilliput	1976 #21	2.42	(0.19)	1.06	(0.15)
	1977 EIS #6	5.12	(0.03)	1.94	(0.05)
Keg Island	1976 #22	1.23	(0.43)	0.61	(0.19)
	1977 EIS #7	3.12	(0.12	0.72	(0.06)
Big Island	1976 #22A	1.68	(0.31)	0.39	(0.09)
Lower Brunswick	1976 #23	1.94	(0.26)	0.62	(0.12)
	1977 EIS #8	5.02	(0.03)	0.92	(0.02)
Upper Brunswick	176 #24	1.46	(0.36)	0.60	(0.16)
	1978 #1	1.29	(0.41)	0.78	(0.23)
Fourth East Jetty	1978 #2	Silt			
Between Channels	1978 #3	Silt			
Anchorage Basin	1977 EIS #9	4.14	(0.06)	0.79	(0.03)
	1976 #25	5.07	(0.03)	2.67	(0.09)
	1976 #26	4.15	(0.06)	2.36	(0.14)
	1978 #4	Silt			
	1978 #5	Silt			

\# Buoy number in ship channel.
* Sample location shown on figure B1 .
** Composite characteristics based on 22 samples collected between buoy #4 and buoy #13.

Table B3

Cost Estimate - Beach Disposal Alternative A1
Periodic Disposal on Fort Fisher

Item	Quantity	Unit Cost	Cost
I. Initial Dredging of Disposal Area 4			
Mobilization and Demobilization	1 Job	L.S.	$ 250,000
Dredging (27" pipeline dredge w/booster)	925,000 cy	$2.45/cy	2,266,000
Subtotal			$2,516,000
Contingencies (15%)			377,000
Subtotal			$2,893,000
Engineering and Design			116,000
Supervision and Administration			145,000
Total Cost Initial Excavation			$3,154,000
II. Temporary Storage in Disposal 4			
Mobilization and Demobilization	1 Job	L.S.	$ 50,000
Dredging (18" pipeline dredge)	178,000 cy	$2.90/cy	516,000
Subtotal			$ 566,000
Contingencies (15%)			85,000
Subtotal			$ 651,000
Engineering and Design			26,000
Supervision and Administration			32,500
Total Cost per Operation			$ 709,500
III. 10-Year Beach Disposal Operation			
Mobilization and Demobilization	1 Job	L.S.	$ 250,000
Dredging (27" pipeline dredge w/booster)	890,000 cy	$2.80/cy	2,492,000
Subtotal			$2,742,000
Contingencies (15%)			411,000
Subtotal			$3,153,000
Engineering and Design			126,000
Supervision and Administration			158,000
Total Cost per Operation			$3,437,000

Table B4

Equivalent Average Annual Cost of Alternative A1
n = 50 years; i = 8-7/8 %

	Item	Annual Cost
(a)	Interest Amortization of Initial Excavation	$284,000
(b)	Temporary Storage	293,000
(c)	10-year Beach Disposal	229,000
	Total Average Annual Cost - A1	$806,000

Table B5

Cost Estimate - Beach Disposal Alternative A2
Periodic Disposal on Kure Beach

Item	Quantity	Unit Cost	Cost
I. Initial Dredging of Disposal Area 4			
Mobilization and Demobilization	1 Job	L.S.	$ 300,000
Dredging (27" pipeline dredge w/booster)	925,000 cy	$3.25/cy	3,006,000
Subtotal			$3,306,000
Contingencies (15%)			496,000
Subtotal			$3,802,000
Engineering and Design			152,000
Supervision and Administration			190,000
Total Cost Initial Excavation			$4,144,000
II. Temporary Storage in Disposal Area 4			
Mobilization and Demobilization	1 Job	L.S.	$ 50,000
Dredging (18" pipeline dredge)	178,000 cy	$2.90/cy	516,000
Subtotal			$ 566,000
Contingencies (15%)			85,000
Subtotal			651,000
Engineering and Design			26,000
Supervision and Administration			32,500
Total Cost Initial Excavation			$ 709,500
III. 10-Year Beach Disposal Operation			
Mobilization and Demobilization	1 Job	L.S.	$ 300,000
Dredging (27" pipeline dredge w/booster)	890,000 cy	$3.30/cy	2,937,000
Subtotal			$3,237,000
Contingencies (15%)			485,000
Subtotal			$3,722,000
Engineering and Design			149,000
Supervision and Administration			186,000
Total Cost per Operation			$4,057,000

TABLE B6

Equivalent Average Annual Cost of Alternative A2
Periodic Disposal on Kure Beach
n = 50 years; i = 8-7/8 %

	Item	Annual Cost
(a)	Interest Amortization of Initial Excavation	$373,000
(b)	Temporary Storage	293,000
(c)	10-year Beach Disposal	270,000
	Total Average Annual Cost - A2	$936,000

TABLE B7

Cost Estimate - Direct Beach Disposal Alternative 1
(Fort Fisher)

Item	Quantity	Unit Cost	Cost
Mobilization and Demobilization	1 Job	L.S.	$ 186,000
Dredging (18" Pipeline dredge w/2 boosters)	178,000 cy	$4.20/cy	748,000
Subtotal			$ 934,000
Contingencies (15%)			140,000
Subtotal			$1,074,000
Engineering and Design			43,000
Supervision and Administration			54,000
Total			$1,171,000
Annual Cost			$ 560,000

TABLE B8

Cost Estimate - Direct Beach Disposal Alternative B2
(Kure Beach)

Item	Quantity	Unit Cost	Cost
Mobilization and Demobilization	1 Job	L.S.	$ 217,000
Dredging (18" pipeline dredge w/2 boosters)	178,000 cy	$6.00/cy	1,068,000
Subtotal			$1,285,000
Contingencies (15%)			193,000
Subtotal			$1,478,000
Engineering and Design			59,000
Supervision and Administration			74,000
Total			$1,611,000
Annual Cost			$ 771,000

TABLE B9

Comparison of Alternative Costs

Disposal Alternative	Average Annual Cost
A1 FF Storage	$806,000
A2 Kure Storage	936,000
B1 FF Direct	560,000
B2 Kure Direct	771,000
Bucket and Barge	$205,000

TABLE B10

Ocean Disposal by Pipeline

Reaches	Type Material	Average Annual Quantity (cy)	Pumping Distances (ft) Max	Min	Avg
Lower Lilliput	Sandy/Silt	45,000	57,900	47,900	52,900
Upper Midnight	Sandy/Silt	118,000	47,900	34,200	41,100
Connecting Channel	Sandy/Silt	19,000	60,100	50,100	55,100
Lower Midnight	Sandy/Silt	26,000	34,200	25,700	30,000
Reaves Point	Sand	25,000	25,700	19,800	22,800
Horseshoe Shoal	Sand	47,000	19,800	16,400	18,100
Snow Marsh	Sand	17,000	35,300	19,800	27,600
Lower Swash	Sand	12,000	43,500	35,300	39,400
		309,000			

The dredging estimate is contained in table B11 and is based on the following:

a. 27" pipeline dredge,
b. Sand,
c. Bank height of 3 feet,
d. Booster factor = 0.729,
e. 18 hours/day - 24 days/month,
f. Average pumping distance in each range, and
g. Biennial dredging.

TABLE B11

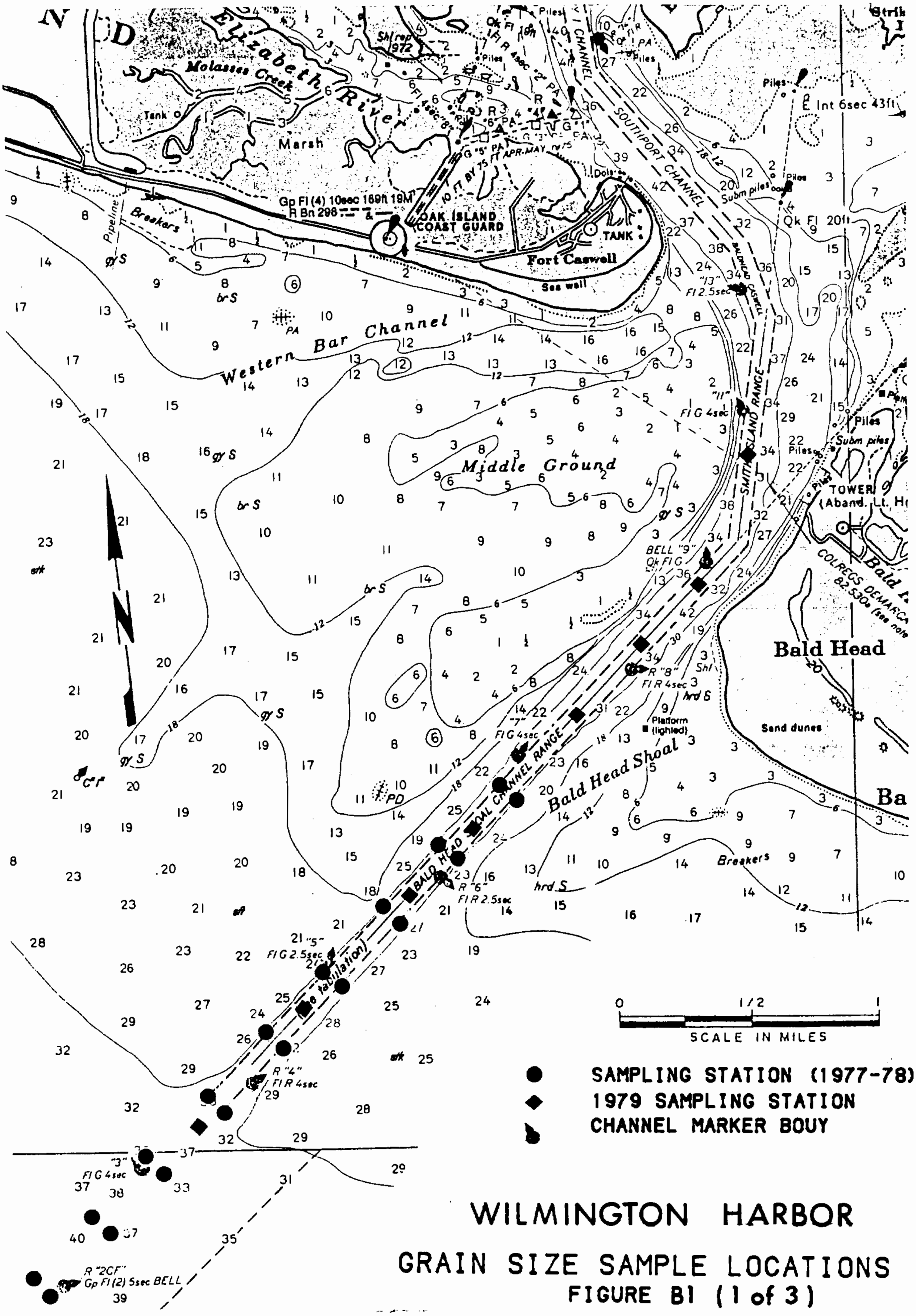
Cost Estimates for Ocean Disposal by Pipeline for the Reaches Indicated in Table B10

Item	Quantity	Unit Cost	Cost
Mobilization and Demobilization	1 Job	LS	$770,000
Dredging (27" pipeline dredge with 3 boosters	618,000 cy	$15.50/cy	9,580,000
Subtotal			$10,350,000
Contingencies (15%)			1,550,000
Subtotal			$11,900,000
Engineering and Design			475,000
Supervision and Administration			595,000
Total			$12,970,000
Annual Costs			$6,207,000

TABLE B12

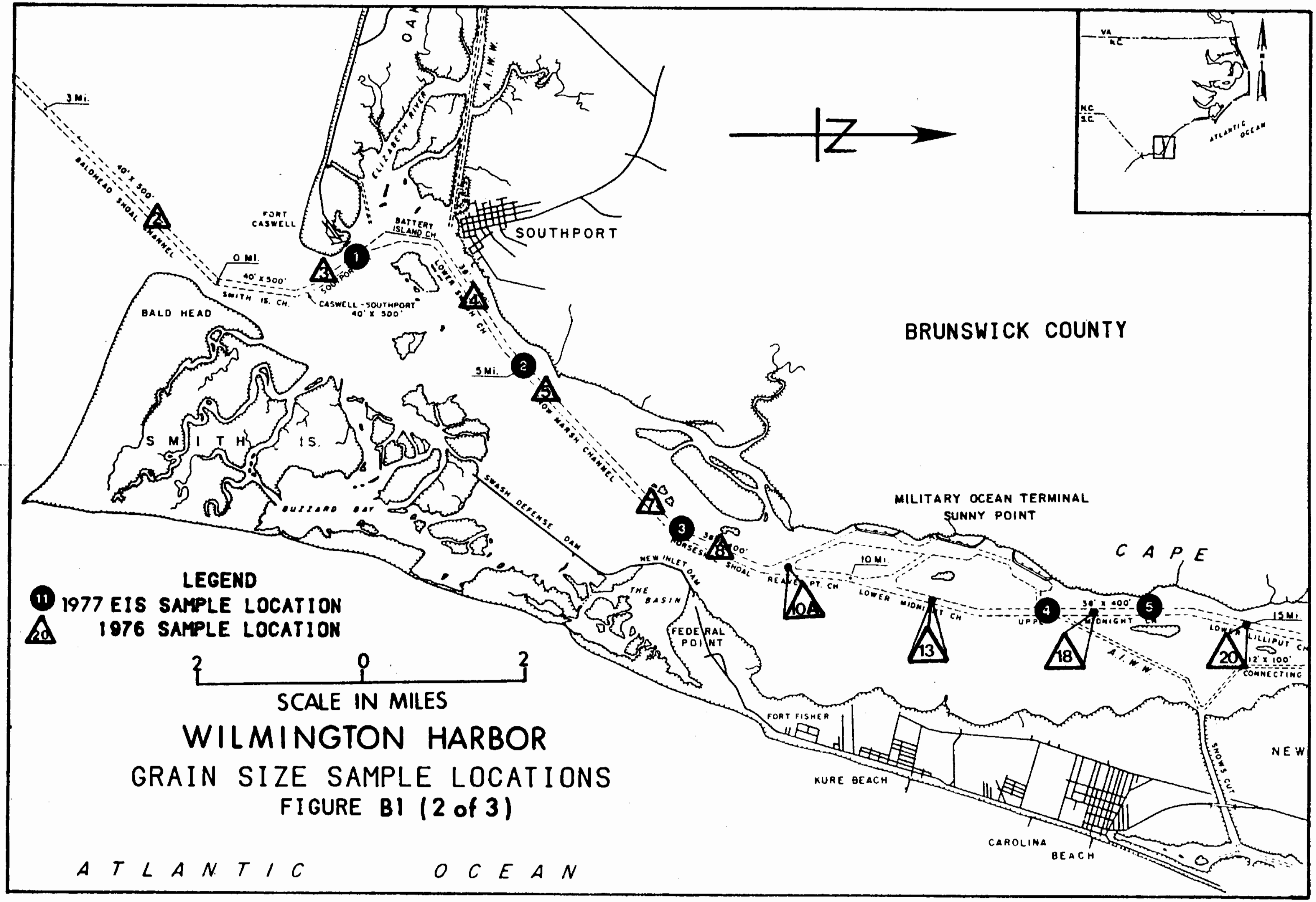
Cost Estimate for Ocean Disposal by Bucket and Barge for the Reaches Indicated in Table B10

Item	Quantity	Unit Cost	Cost
Mobilization and Demobilization	1 Job	LS	$ 300,000
Biennial Dredging	618,000 cy	$2.40/cy	1,483,200
Subtotal			$1,783,200
Contingencies (15%)			267,500
Subtotal			$2,050,700
Engineering and Design			82,000
Supervision and Administration			102,500
Total			$2,235,200
Annual Costs			$1,070,000

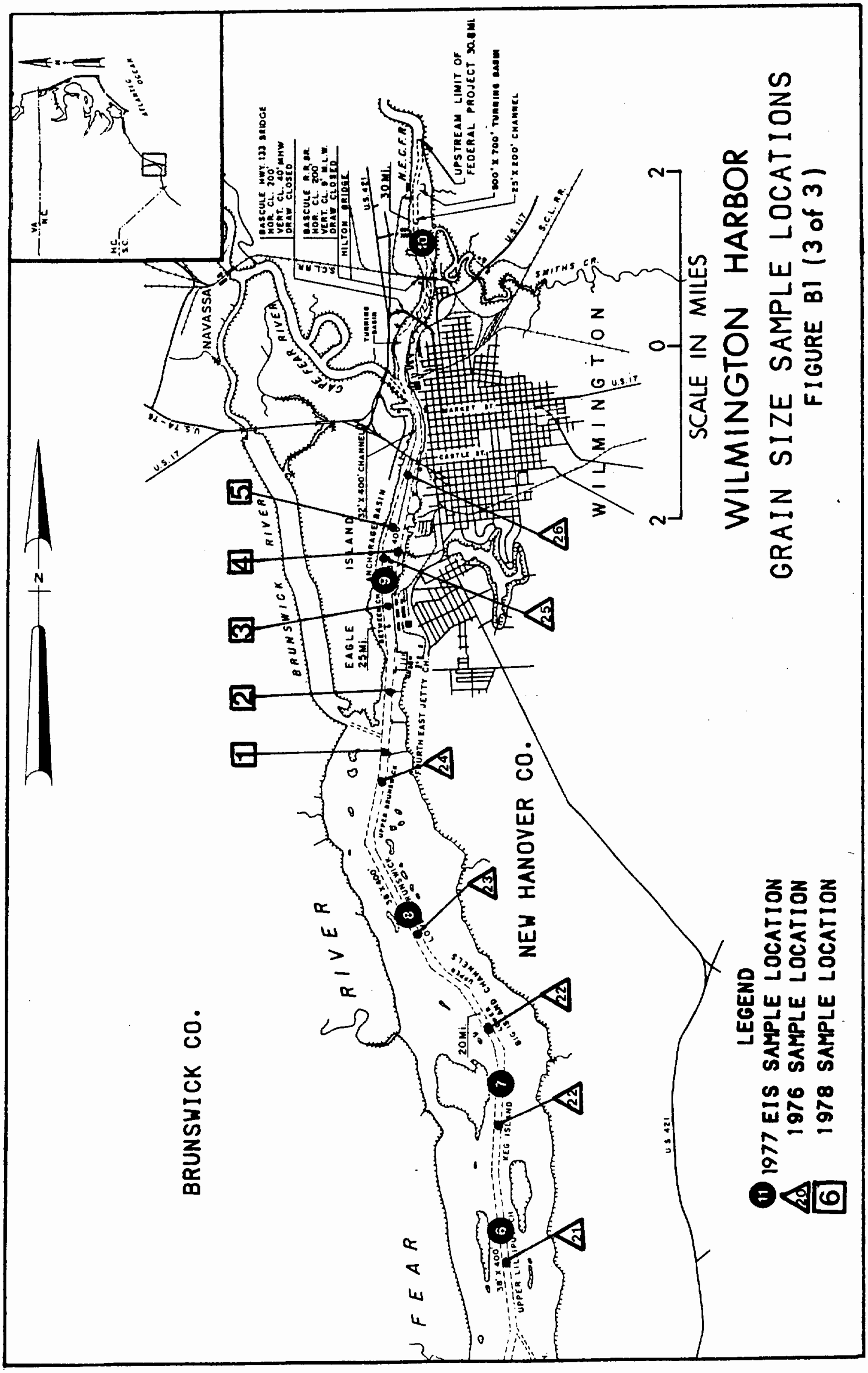


WILMINGTON HARBOR

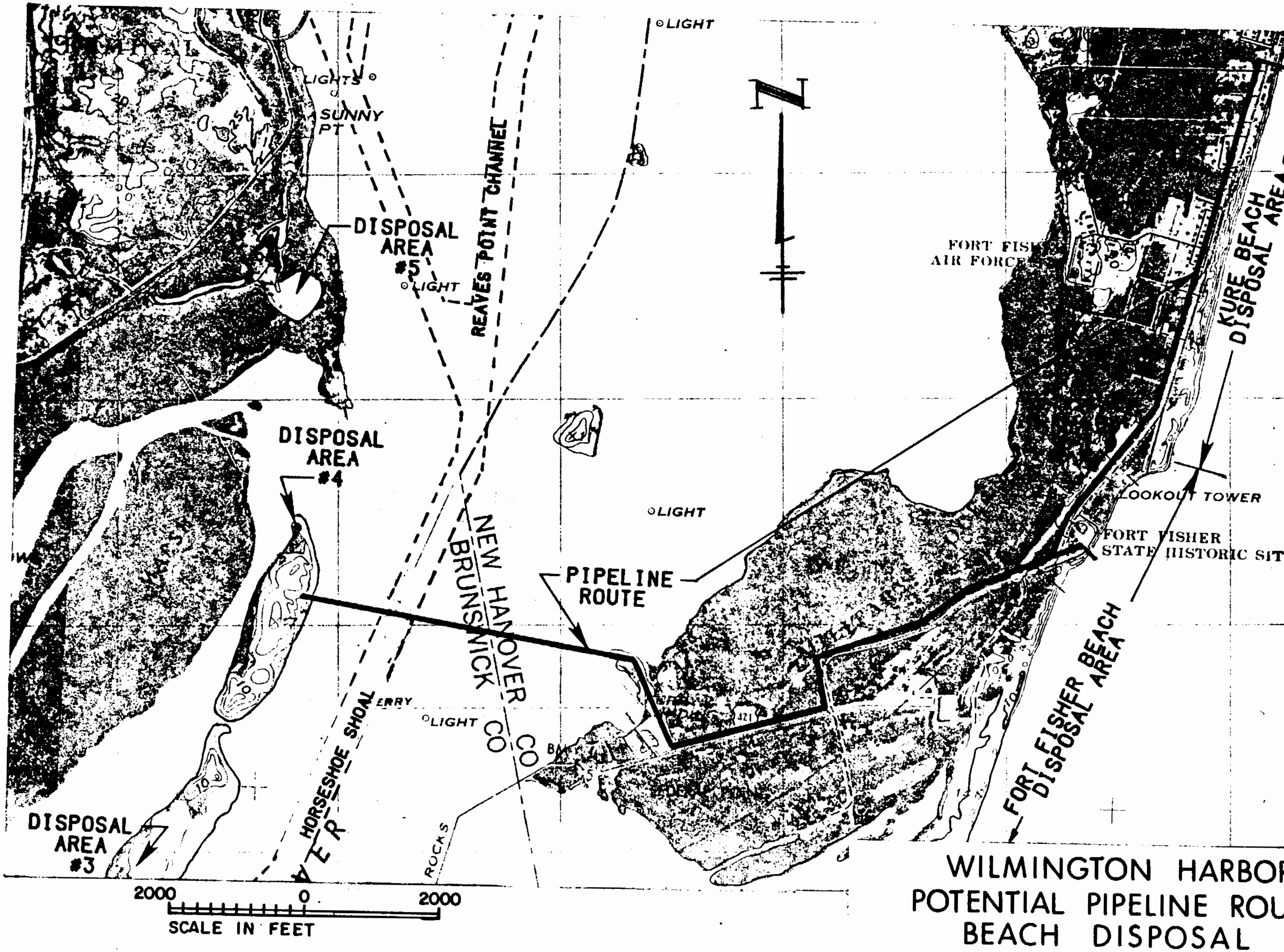
GRAIN SIZE SAMPLE LOCATIONS
FIGURE B1 (1 of 3)



WILMINGTON HARBOR
GRAIN SIZE SAMPLE LOCATIONS
FIGURE B1 (2 of 3)



WILMINGTON HARBOR
GRAIN SIZE SAMPLE LOCATIONS
FIGURE B1 (3 of 3)



WILMINGTON HARBOR
POTENTIAL PIPELINE ROUTE
BEACH DISPOSAL

FIGURE B2

APPENDIX C

Long-Term Maintenance of Wilmington Harbor
North Carolina

GEOLOGY

APPENDIX C

Long-Term Maintenance of Wilmington Harbor
North Carolina

GEOLOGY

Regional Geological Setting. Wilmington Harbor is in the Cape Fear area of the Atlantic Coastal Plain Physiographic province. The geomorphology of the Cape Fear area was created by events such as emergence and submergence of the Coastal Plain, deposition and erosion of sediments, development of the Cape Fear River, and wave and current action of the Atlantic Ocean.

A basement structural high, underlying the Cape Fear area is the Cape Fear Arch. There are no apparent topographic expressions attributed to the Cape Fear Arch. It has a gentle warp with the axial plunge increasing sharply near the shoreline and gradually diminishing updip toward the Fall Line. The arch is assymetric in cross section, the north limb being steeper. It is thought to have become a positive structure through the downwarping of its flanks during the late, middle Eocene Epoch (about 38 to 54 m.y.a.). The depth to basement rock at Cape Fear is about 1,100 feet.

The sediments that comprise the Coastal Plain are wedge shaped, with the thin edge at the Fall Line and thickening toward the Atlantic Ocean. These sediments overlie older Paleozoic-Precambrian (greater than 195 m.y.a.) age rocks. The Fall Line is the boundary where the coastal sediments interface with the older Paleozoic-Precambrian age rocks of the Piedmont. The sediments dip to the southeast at about 13 feet per mile at Cape Fear and range in age from Cretaceous Period (65 to 135 m.y.a.) to the Recent with the oldest exposed at the west and the youngest at the east.

Cape Fear Area Geology and Soils. The soils of the Cape Fear area reflect the coastal environment of deposition. These types of depositions may be barrier, backbarrier, marsh-swamp, open ocean, and marginal marine. Most of the Atlantic coast from Wrightsville Beach, North Carolina to the North Carolina-South Carolina border is flanked by predominantly Holocene age (10,000 years ago to present) barriers. The southern tip of Smith Island is a Holocene barrier, while the north end of Smith Island to south of Snows Cut is part of the Myrtle Beach barrier (Pleistocene, 1.8 m.y.a. to 10,000 years ago) with Holocene surficial deposits on the seaward side at the shoreline.

The formations names of the rock and sediment commonly encountered in the Cape Fear area are shown in table C1.

The soil and rock encountered in the Cape Fear area range may be categorized into three groups: 1) surficial sand (Holocene), 2) Pleistocene sediments, and 3) the Castle Hayne Limestone. Generally, the uppermost sediments are poorly graded surficial sands with little or no fines (SP); Holocene in age, and buff colored. These Holocene sands may be indistinguishable from the underlying buff colored Pleistocene age Socastee sand (usually found adjacent to the coast). The Holocene age sands and the Socastee sand is also referred to as the surficial sand aquifer. Underlying the Socastee formation is the Canepatch formation. It consists of admixtures of sand, clay, silt, and peat and in some areas coquina is present. Silty and sandy, blue to gray clay are present. Shell fragments or layers of shell fragments may be found in the Socastee and the Canepatch formations. The Canepatch formation acts as an aquitard between the surficial or upper sands and the underlying Waccamaw and Bear Bluff formations. The boundary between the Waccamaw and Bear Bluff formations is difficult to distinguish and for this report are considered as a single unit. The Waccamaw and the Bear Bluff form the marine sand aquifer. The Waccamaw and the Bear Bluff are usually composed of green-gray to blue-gray silty sand or sand. The sand may have varying degrees of induration and may have an abundance of mollusk and echinoid shells. Finally, the Castle Hayne formation is encountered below the Bear Bluff and Waccamaw formations. The Castle Hayne is a poorly to well cemented limestone sometimes argillaceous in places. It is occasionally very fossiliferous with echinoderm fragments. In other places it may have numerous mollusk casts and molds.

<u>Various Characteristics of the Pleistocene Sediments and Eocene Limestone</u>. In and along the Cape Fear River from dredge disposal areas 3 to 15, significant characteristics of individual geologic formations are encountered. The top of the Castle Hayne formation was irregularly eroded before the deposition of the Bear Bluff formation. Karst topography in some areas of New Hanover and Brunswick counties indicates solutioning of the Castle Hayne which supports the Pleistocene overburden. The morphological development of the Cape Fear River may have left buried river channels and flood plain deposits. There also appears to be Castle Hayne limestone pinnacles which may be erosional or solution remnants.

<u>Drilling logs</u>. The drilling logs for the borings taken in Wilmington Harbor are available upon request.

TABLE C1

Geologic Formations Commonly Encountered in the Surface or near Subsurface in the Cape Fear Area.

NAME	GEOLOGICAL TIME Epoch	
1. Undifferentiated	Holocene	Recent
2. SOCASTEE	Pleistocene	10,000 years ago to 1.8 million years ago (abbreviated m.y.a.)
3. CANEPATCH	Pleistocene	overlain by the Socastee
4. WACCAMAW	Pleistocene	overlain by the Canepatch
5. BEAR BLUFF	Pliocene	5 to 1.8 m.y.a.
6. CASTLE HAYNE	Eocene	38 to 54 m.y.a.

APPENDIX D

Long-Term Maintenance of Wilmington Harbor
North Carolina

ECONOMICS

APPENDIX D

Long-Term Maintenance of Wilmington Harbor
North Carolina

ECONOMICS

MAINTENANCE COSTS

Costs of maintaining Federal navigation projects are borne both by the Federal Government and non-Federal interests. In instances where only commercial navigation is served by the project, as is the case for Wilmington Harbor, the traditional Federal responsibility includes all costs for actual maintenance dredging of the authorized project. The Water Resources Development Act of 1986 calls for cost sharing of harbor maintenance dredging costs through a 0.04 percent fee assessed on value of cargo unloaded at the port. Costs for diking of disposal areas, any necessary lands, easements, and rights-of-way, and costs for dredging access channels to the Federal project would still be the responsibility of the non-Federal interests. The North Carolina Department of Natural Resources and Community Development has contributed funds for diking disposal areas and the NC State Ports Authority (NCSPA) has provided funds for dredging berths at the State Ports. A summary of maintenance costs for Fiscal Years (FY) 1981-1986 is shown in table D1.

A project length of nearly 31 miles in itself can cause maintenance problems, such as physically locating the necessary disposal areas and the associated costs of maintaining project dimensions over that distance. It should be noted, however, that the costs of maintenance have not been proportionately greater than that at Morehead City, where project length is much less.

Maintenance costs at several ports were compared to the costs at Wilmington harbor on a per-ton basis. The ports of Charleston and Savannah had a recent cost of about 70 cents per ton and Wilmington and Morehead City averaged about 80 cents per ton. Both Charleston and Savannah handle more tons of commerce, and all three maintain a shorter channel distance than Wilmington.

TRENDS IN WATERBORNE TRANSPORTATION

Containers. Trends in shipping are toward greater use of containers, since cargo can be handled with greater ease and efficiency. Container facilities for commercial traffic in Wilmington Harbor are located at the State Ports. The first container crane was placed in operation in 1978, a second in 1979-1980, and a third in late 1984. It appears that the introduction of the cranes has had an impact on commerce handled through the NCSPA. RTI (1983) found that the annual compound rate of growth of total NCSPA traffic was 7.9 percent during the 1970's, with much of the growth concentrated in the last half of the decade. Two additional container cranes are proposed in conjunction with a new 900-foot berth to begin operation in 1990.

Statistical analysis of historical commerce data done by RTI (1983) indicates that the container cranes have had a significant impact on the volume of port traffic. The analysis indicated that exports increased each time that a container crane was installed. In addition to the baseline projections of NCSPA traffic without additional cranes added, RTI (1983) developed projections of commerce based on an increase to four cranes by 1990 and six cranes by the year 2000. Projections for total NCSPA commerce for the period FY 1987 to 1990 are shown in table D2. These represent a refinement of longer range projections from the RTI (1983) report.

Traffic through the State Ports has generally held its own under fluctuating conditions, and managed a large increase in container tonnage in FY 1986. Also, the percentage of container traffic to total NCSPA traffic has increased from 1981 to 1986. The relationship between container tonnage and total tonnage for the last 6 fiscal years is given in table D3.

NCSPA management believes that container traffic for the port of Wilmington will continue this rapid expansion. NCSPA anticipates a container tonnage of about 830,000 tons in FY 1990 (see table D2). There are now five full container lines operating with the equivalent of an additional three lines which operate privately (i.e., handle their own cargo rather than soliciting business). Maintenance to the existing channels is crucial to the container traffic, especially the larger ships.

Intermodal Terminals. In January 1984, the NCSPA opened an "inland port" shipping terminal in Charlotte, referred to as the Charlotte Intermodal Terminal. This facility is a container-staging and storage area. Trucks bring in containers to the terminal, where they are loaded on trains for shipment to Wilmington. In addition to cutting costs to shippers by the bulk movement of containers, NCSPA officials indicate that they have a very favorable rail rate from Charlotte, which makes the State Ports more competitive from there to Wilmington than to Charleston, South Carolina.

Recently, a similar "inland port" facility was opened in Greensboro, with containers moved to the docks by truck. This facility provides cheaper transportation rates to the port by coordinating container movements and storing empty containers. These kinds of facilities point out the importance of Wilmington Harbor in other parts of the the state. (Sources: N.C. State Ports Authority and Gloria Sajgo, "North Carolina's Seaports and the State Ports Authority", contained in Popular Government, Winter 1985.)

Military Uses. The Military Ocean Terminal Sunny Point (MOTSU) is located on the west bank of the Cape Fear River, about 15 miles south of Wilmington and five miles north of Southport, North Carolina. It is the first installation in the United States to be designed specifically for the transfer of ammunition and explosive cargo from land modes to sea lift or vice versa. The MOTSU mission is to plan, coordinate, and accomplish the movement of ammunition and other dangerous cargo through Sunny Point, and other assigned cargo through terminal facilities in Wilmington.

The port of Wilmington has handled military traffic for the pre-positional force, as well as regular exercises which occur at various times. As of

November 1984, some NCSPA land was being converted to use for the military, with additional acreage to be developed in the future. Low clearance of a powerline crossing below Wilmington limits the superstructure of ships that can call at the port, affecting the military traffic. The NCSPA is trying to find funds to relocate or raise this powerline, but have not succeeded as yet. Military traffic is heavily dependent on the regular maintenance dredging of the harbor.

Vessel Trends. Vessels have increased in size, both in length and deadweight tonnage, over the years. Those using Wilmington Harbor include tankers, large bulk carriers, large container ships, and general cargo vessels. Container vessels, which make a large number of calls at the NCSPA docks, are being increased in length at the present time, some to about 900 feet. Vessels in the "Panamax" class have beams of 106 feet, drafts of about 35-38 feet, and lengths of 800-950 feet.

Foreign Trade Zone. The foreign trade zone, sometimes referred to as the free trade zone (FTZ), is a special service designation made by the NCSPA at the port of Wilmington in 1981. This is a special customs area into which goods can be imported with no payment of duty until they are shipped domestically. If re-exported, no duty is paid. While in the zone, any number of activities can be performed on the shipment. The users of the zone benefit from deferred or reduced duty payment or avoidance of duty payment (on re-exported items, damaged goods, and packing). The area benefits from the jobs and income generated by work in the zone, and the NCSPA benefits from fees paid for use of the land. (Source: Gloria Sajgo, "North Carolina's Seaports and the State Ports Authority", Popular Government, Winter 1985.)

There was only limited use of the FTZ in Wilmington until the summer of 1983 when the first two permanent residents began operations. One is a foreign car import operation which refits imports to meet U.S. emission and safety standards and then resells them worldwide. The other is an export trading company. (Source: Sajgo, as above.)

Other Regional Ports. The five major ports in Virginia, the Carolinas, and Georgia are Hampton Roads, (which includes Norfolk Harbor, Port of Newport News, Hampton Creek, and Channel), Morehead City, Wilmington, Charleston, and Savannah. Wilmington Harbor handled nine percent of the total average yearly volume for these five ports for the 10-year period 1973-1982. Of the five ports Hampton Roads, handled by far the most tonnage, averaging approximately two-thirds of the total. The remaining port percentages are Morehead City-2.8, Wilmington- 9.1, Charleston-9.7, and Savannah-10.8. Both Wilmington Harbor and Morehead City Harbor handled a yearly average of 11,656,056 tons for the period, of which Wilmington Harbor contributed approximately 76 percent.

In 1984, Wilmington ranked 20th in the nation in container traffic with 0.7 per cent of the total, about equal with Boston and Jacksonville. Norfolk, Charleston, and Savannah ranked 7th, 8th, and 9th, respectively.

Land for Port Expansion. As mentioned in the Military Uses section, some NCSPA land has been converted to use for the military, with additional acreage planned for the future. The proposed new container berth will expand the existing wharf to approximately the NCSPA southern boundary. Future expansion is expected to be to the north. The NCSPA owns a tract of approximately 52 acres immediately north of their docks, of which about half are developable. The NCSPA is also hoping to acquire the former Southern Wood Piedmont property adjacent to their northern boundary from the city of Wilmington for future expansion.

Only a few undeveloped sites with harbor access remain in Wilmington. Land adjacent to the channel is available in Brunswick County, and recent industrial and shipping proposals have centered in that area. Most new port users in recent years have bought developed facilities from existing users. At the present time, there are no announced plans for development of new industrial docks.

TABLE D1

<u>Maintenance Costs*</u>
<u>FY 81-86</u>

<u>Wilmington Harbor</u>

	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	Average FY 81-86
Federal Funds	$2,814,849	$2,346,392	$5,847,149	$2,513,647	$3,997,363	$2,553,488	$3,345,481
Contributed (actual cost)							
Diking Disposal Areas	109,970	301,120	75,000	255,004	450,000	258,112	241,534
State Ports Dredging[1]	-	125,629	(2)	-	43,500	140,539	51,612
Subtotal - Contributed	$ 109,970	$ 426,749	$ 75,000	$ 255,004	$ 493,500	$ 398,651	$ 293,146
Total	$2,924,819	$2,773,141	$5,922,149	$2,768,651	$4,490,863	$2,952,139	$3,638,627

[1] Berths, etc., not part of Federal project.

[2] Does not include $205,371 contributed funds (total from State) for widening the anchorage basin opposite the State Ports in October 1982. This new work, authorized July 13, 1982, was accomplished with maintenance funds under special authority contained in Section 5 of the Congressional Appropriations Act of 1915.

* U.S. Army Corps of Engineers, <u>Annual Report of the Chief of Engineers on Civil Works Activities; Extract - Report of the Wilmington, N.C. District, Fiscal Years 1984 and 1986.</u>

TABLE D2

CARGO PROJECTIONS
N. C. STATE PORT AT WILMINGTON

Category	FY 1986	FY 1987	FY 1988	FY 1989	FY 1990
Container Freight	652,466	648,000	703,000	759,000	828,000
Breakbulk	589,857	765,000	800,000	825,000	850,000
Dry Bulk	71,854	103,290	103,290	103,290	103,290
Liquid Bulk	1,267,065	1,384,170	1,384,170	1,384,170	1,384,170
Military Activities	60,484	60,000	60,000	60,000	60,000
Total (All Types)	2,641,726	2,960,460	3,050,460	3,131,460	3,225,460

All figures in short tons, FY 1986 is actual, FY begins July 1
Source: N. C. State Ports Authority

TABLE D3

Container and Total Traffic at the NC State Port

TRAFFIC (TONS)	1981	1982	1983	1984	1985	1986
Container	421,662	502,439	521,391	509,144	479,963	653,424
Total NCSPA	2,734,974	2,577,380	2,349,055	2,704,734	2,573,108	2,641,726
% Cont./NCSPA	15.4	19.5	22.2	18.8	18.7	24.7

APPENDIX E

Long-Term Maintenance of Wilmington Harbor
North Carolina

EVALUATION OF SECTION 404(b)(1) GUIDELINES

APPENDIX E
Long-Term Maintenance of Wilmington Harbor (LTMWH)
North Carolina

Evaluation of Section 404(b)(1) Guidelines
40 CFR 230

Section 404 Public Notice No. CESAW-PD-89-N-10-65-0007

		Preliminary 1/	Final 2/
1.	Review of Compliance (230.10(a)-(d)) A review of the NEPA Document indicates that:		
	a. The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose (if no, see section 2 and information gathered in the NEPA document);	YES|X| NO|_|*	YES|X| NO|_|
	b. The activity does not: 1) violate applicable State water quality standards or effluent standards prohibited under Section 307 of the CWA; 2) jeopardize the existence of federally listed endangered or threatened species or their habitat; and 3) violate requirements of any federally designated marine sanctuary (if no, see section 2b and check responses from resource and water quality certifying agencies);	YES|X| NO|_|*	YES|X| NO|_|
	c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, esthetic, and economic values (if no, see section 2);	YES|X| NO|_|*	YES|X| NO|_|
	d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (if no, see section 5).	YES|X| NO|_|*	YES|X| NO|_|

Proceed to Section 2
*, 1, 2/ See page E-7

2. Technical Evaluation Factors (Subparts C-F)

	N/A	Not Significant	Significant*
a. Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)			
(1) Substrate impacts.		X	
(2) Suspended particulates/turbidity impacts.		X	
(3) Water column impacts.		X	
(4) Alteration of current patterns and water circulation.	X		
(5) Alteration of normal water fluctuations/hydroperiod.	X		
(6) Alteration of salinity gradients.	X		
b. Biological Characteristics of the Aquatic Ecosystem (Subpart D)			
(1) Effect on threatened/endangered species and their habitat.		X	
(2) Effect on the aquatic food web.		X	
(3) Effect on other wildlife (mammals, birds, reptiles, and amphibians).		X	
c. Special Aquatic Sites (Subpart E)			
(1) Sanctuaries and refuges.	X		
(2) Wetlands.		X @	
(3) Mud flats.		X	
(4) Vegetated shallows.	X		
(5) Coral reefs.	X		
(6) Riffle and pool complexes.	X		
d. Human Use Characteristics (Subpart F)			
(1) Effects on municipal and private water supplies.	X		
(2) Recreational and commercial fisheries impacts.		X	
(3) Effects on water-related recreation.		X	
(4) Esthetic impacts.		X	
(5) Effects on parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves.	X		

Remarks: Where a check is placed under the significant category, preparer add explanation below.

@ 2(c)(2) See sections 3.2.2, 4.2.3 and 5.2.3 of the FEIS, LTMWH.

Proceed to Section 3

*See page E-7

3. Evaluation of Dredged or Fill Material (Subpart G) 3/
   a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material. (Check only those appropriate.)

      (1) Physical characteristics. . . . . |X|
      (2) Hydrography in relation to known or anticipated sources of contaminants . . . . |X|
      (3) Results from previous testing of the material or similar material in the vicinity of the project . . . . |X|
      (4) Known, significant sources of persistent pesticides from land runoff or percolation. |_|
      (5) Spill records for petroleum products or designated (Section 311 of CWA) hazardous substances. |_|
      (6) Other public records of significant introduction of contaminants from industries, municipalities, or other sources . . . . |_|
      (7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities . . . . |_|

      (8) Other sources (specify) . . . . |_|

      List appropriate references.

      FEIS, LTMWH

   b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to result in degradation of the disposal site. The material meets the testing exclusion criteria. YES |X| NO |_|*

Proceed to Section 4

*, 3/, see page E-7

4. Disposal Site Determinations (230.11(f)).
   a. The following factors as appropriate, have been considered in evaluating the disposal site.

      (1) Depth of water at disposal site . . . . |X|

      (2) Current velocity, direction, and variability at disposal site . . . . |X|

      (3) Degree of turbulence . . . . |X|

      (4) Water column stratification . . . . |X|

      (5) Discharge vessel speed and direction . . . . |X|

      (6) Rate of discharge . . . . |X|

      (7) Dredged material characteristics (constituents, amount and type of material, settling velocities). . . . .|X|

      (8) Number of discharges per unit of time . . . . |X|

      (9) Other factors affecting rates and patterns of mixing (specify)

      List appropriate references.

      FEIS, LTMWH

   b. An evaluation of the appropriate factors in 4a above indicates that the disposal site and/or size of mixing zone are acceptable . . . .YES |X| NO |_|*

5. Actions to Minimize Adverse Effects (Subpart H).

   All appropriate and practicable steps have been taken, through application of recommendations of 230.70-230.77, to ensure minimal adverse effects of the proposed discharge. List actions taken. YES |X| NO |_|*

   For wetlands, see sections 3.2.2, 4.2.3, and 5.2.3 of the FEIS. For water quality, see sections 3.2.1.1, 3.2.1.3, and 5.1.4.2 of the FEIS.

Return to section 1 for final stage of compliance review. See also note 3/, page E-7

*See page E-7

6. Factual Determinations (230.11).

A review of appropriate information as identified in items 2-5 above indicates that there is minimal potential for short- or long-term environmental effects of the proposed discharge as related to:

a. Physical substrate at the disposal site (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

b. Water circulation, fluctuation, and salinity (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

c. Suspended particulates/turbidity (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

d. Contaminant availability (review sections 2a, 3, and 4). YES |X| NO |_|*

e. Aquatic ecosystem structure and function (review sections 2b and c, 3, and 5). YES |X| NO |_|*

f. Disposal site (review sections 2, 4, and 5). YES |X| NO |_|*

g. Cumulative impact on the aquatic ecosystem. YES |X| NO |_|*

h. Secondary impacts on the aquatic ecosystem. YES |X| NO |_|*

7. Findings.

a. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines. . . . . |X|

b. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines with the inclusion of the following conditions: |_|

*See page E-7

c. The proposed disposal site for discharge of dredged or fill material does not comply with the Section 404(b)(1) guidelines for the following reasons(s):

(1) There is a less damaging practicable alternative. . . . . |_|

(2) The proposed discharge will result in significant degradation of the aquatic ecosystem . . . . |_|

(3) The proposed discharge does not include all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem . . . . |_|

8.

Lawrence W. Saunders	Thomas C. Suermann
Chief, Planning Division	Lieutenant Colonel,
	Corps of Engineers
	District Engineer
Date: 13 Sept 89	Date: 18 Sept 89

*A negative, significant, or unknown response indicates that the permit application may not be in compliance with the Section 404(b)(1) Guidelines.

1/ Negative responses to three or more of the compliance criteria at this stage indicate that the proposed projects may not be evaluated using this "short form procedure." Care should be used in assessing pertinent portions of the technical information of items 2 a-d, before completing the final review of compliance.

2/ Negative response to one of the compliance criteria at this stage indicates that the proposed project does not comply with the guidelines. If the economics of navigation and anchorage of Section 404(b)(2) are to be evaluated in the decision-making process, the "short form evaluation process is inappropriate."

3/ If the dredged or fill material cannot be excluded from individual testing, the "short-form" evaluation process is inappropriate.

APPENDIX F

Long -Term Maintenance of Wilmington Harbor
North Carolina

Biological Opinions under the Endangered Species Act of 1973, as Amended

United States Department of the Interior
FISH AND WILDLIFE SERVICE

Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

September 26, 1988

Colonel Paul W. Woodbury
District Engineer
U.S. Army Corps of Engineers
P. O. Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel Woodbury:

We have reviewed your July 29, 1988 biological assessment of the long-term maintenance of Wilmington Harbor, New Hanover and Brunswick Counties, North Carolina, with regard to potential impacts to species protected under the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531-1543).

The biological assessment is adequate and supports the conclusion of no effect with which we concur. In view of this, we believe that the requirements of Section 7 of the Act have been satisfied. However, obligations under Section 7 of the Act must be reconsidered if: (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is subsequently modified in a manner which was not considered in this biological assessment; or, (3) a new species is listed or critical habitat determined that may be affected by the identified action.

Your interest and initiative in enhancing endangered and threatened species are appreciated.

Sincerely yours,

L.K. Mike Gantt

L.K. Mike Gantt
Field Supervisor

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

Dec. 23, 1988

Colonel Paul W. Woodbury
U.S. Department of the Army
Wilmington District
Corps of Engineers
Wilmington, N.C. 28402-1890

Dear Colonel Woodbury:

This responds to your July 29, 1988, request for an Endangered Species Act (ESA) Section 7 Consultation on proposed long-term maintenance of the Wilmington Harbor Project. A Biological Assessment (BA) was transmitted by the Corps of Engineers pursuant to Section 7 of the Endangered Species Act of 1973 (ESA).

Enclosed is the Biological Opinion prepared by the National Marine Fisheries Service (NOAA Fisheries). In formulating this opinion, NOAA Fisheries used the best available information, including scientific and commercial data. The opinion addresses the potential impacts of annual maintenance dredging of the 30.8 mile long project on endangered and threatened species. We conclude that these actions are not likely to jeopardize the continued existence of any listed species under our jurisdiction, but that the activity may result in the injury or mortality of individual shortnose sturgeon or Kemp's ridley, green, or loggerhead sea turtles. Therefore, pursuant to Section 7(b)(4) of the ESA, we have established a low level of incidental take and terms and conditions that we believe are necessary to minimize and monitor such impacts. These terms and conditions are contained in the enclosed "Incidental Take Statement."

I look forward to continued cooperation in future consultations.

Sincerely,

James W. Brennan

James W. Brennan
Assistant Administrator
for Fisheries

Enclosures

ENDANGERED SPECIES ACT

SECTION 7 CONSULTATION

BIOLOGICAL OPINION

Agency: U.S. Army Corps of Engineers (COE), Wilmington District

Activities: Long-term Maintenance Dredging of the Wilmington Harbor Project.

Consultation Conducted By: National Marine Fisheries Service (NOAA Fisheries), Southeast Region

Date Issued: DEC 23 1988

Background:

In accordance with Section 7(a) of the Endangered Species Act, the Wilmington District COE in a letter dated July 29, 1988, initiated consultation on proposed long-term maintenance of the Wilmington Harbor Project. This consultation was to consider the potential impacts of annual removal of approximately 2,300,000 cubic yards of shoal sediments from the project area. Of particular concern, was the potential impacts of this project on recently discovered populations of shortnose sturgeon (Acipenser brevirostrum) in the Brunswick River, North Carolina.

On January 4, 1988, the Wilmington District COE initiated consultation for navigation improvements of the Wilmington Harbor - Northeast Cape Fear River Project by requesting a list of endangered and threatened species under NOAA Fisheries jurisdiction. In a letter of January 12, 1988, NOAA Fisheries provided a list of all endangered and threatened species under our jurisdiction known to occur in North Carolina waters, suggesting that the loggerhead turtle, the Kemp's ridley turtle and the shortnose sturgeon were most likely to be affected by the proposed activity. In subsequent communications with the COE, NOAA Fisheries indicated that the same species might be affected by long-term maintenance dredging of the Wilmington Harbor Project. On July 29, 1988, the COE transmitted a Biological Assessment (BA) concluding that the "continued operation and maintenance of the project will not affect any listed species."

This biological opinion responds to the COE July 29, 1988, letter. The conclusions offered in this opinion are based on current information on the distributions and abundance of threatened and endangered species that may occur in the project area, and the probable effects of annual maintenance dredging on these listed species.

Proposed Activities

This project consists of a channel (40 feet deep, 500 feet wide) through the ocean bar, up the Cape Fear River, 38 feet deep, 400 feet wide, with increased width at bends, to the upstream end of the anchorage basin (foot of Castle Street) at Wilmington. Dredging in the protected reaches of the channel is accomplished using pipeline, bucket and barge, or clamshell dredges. A seagoing hopper dredge is used in the ocean bar channels.

Listed Species likely to occur in the project area

Listed species under the jurisdiction of the NOAA Fisheries that may occur in the project area and may be affected by the proposed action include:

(1) the endangered right whale - Balaena glacialis
(2) the threatened loggerhead turtle - Caretta caretta
(3) the endangered/threatened green turtle - Chelonia mydas
(4) the endangered Kemp's ridley turtle - Lepidochelys kempi
(5) the endangered shortnose sturgeon - Acipenser brevirostrum

Green turtles in U.S. waters are listed as threatened, except for the Florida breeding population which is listed as endangered.

Additional species known to occur along the North Carolina coast include:

(1) the finback whale - Balaenoptera physalus
(2) the humpback whale - Megaptera novaeangliae
(3) the sei whale - Balaenoptera borealis
(4) the hawksbill turtle - Eretmochelys imbricata
(5) the leatherback turtle - Dermochelys coriacea

NOAA Fisheries has determined that these species are unlikely to be affected by the proposed activity.

Biology and distribution of Species

Right whale (Balaena glacialis)

Right whale populations in the North Atlantic are estimated at a few hundred individuals (NMFS 1984). In the western North Atlantic, stocks of right whales are seasonally abundant in areas such as the Great South Channel, at the mouth of the Bay of Fundy and on Brown's Bank (NMFS 1985). During winter months, a portion of the population moves from the summer foraging grounds to the calving/breeding grounds off Florida-South Carolina. Aerial surveys in February 1984, between Ossabaw Island, Georgia, and Jupiter Inlet, Florida, revealed the presence of 13 right whales including four cow/calf pairs (Kraus, pers. comm.). During 1985 winter surveys which began in early February, an additional 10 right whales were sighted (Anon. 1985). These data, observations by the right whale sighting network, and aerial surveys conducted by the University of Rhode Island, indicate the presence of a right whale calving area off the southeastern coast of the United States. The majority of these sightings have occurred off the coast of Georgia, but three cow/calf pairs were observed within five miles of the Florida shoreline.

Right whales feed primarily on copepods, but also take euphasids. Calves are produced in late winter; adult females calve every three to four years. Sexual maturity is reached at about eight years (size at this stage is from 30-40 feet in length). This species was decimated during the 1800's by commercial whaling fleets; it was the preferred target species because right whales floated and were easily butchered. Present populations of right whales are estimated at about 1-4% of the initial populations.

Loggerhead turtle (Caretta caretta)

The threatened loggerhead turtle is the most abundant sea turtle species occurring in U.S. waters. Loggerheads inhabit coastal areas of the continental shelf where they forage around rocky places, coral reefs, shellfish beds and old boat wrecks; they commonly enter bays, lagoons and estuaries (Ernst and Barbour 1972). Aerial surveys of loggerhead turtles at sea indicate that they are most common in waters less than 50 m in depth (Shoop et al. 1981; Fritts et al. 1983), but they occur pelagically as well. The primary food sources of the loggerhead turtle are benthic invertebrates including molluscs, crustaceans and sponges (Mortimer 1982). Crabs and conchs were identified (Carr 1952) as the most frequently found items in stomachs, although loggerheads often eat fish, clams, oysters, sponges and jellyfish. Ernst and Barbour (1972) included marine grasses and seaweeds, mussels, borers, squid, shrimp, amphipods, crabs, barnacles and sea urchins among the foods of loggerhead turtles. The horseshoe crab (Limulus polyphemus) has been identified as a major food source of loggerheads in Mosquito Lagoon, Florida (Mortimer 1982).

In U.S. waters, loggerhead turtles commonly occur throughout the inner continental shelf. Populations of loggerheads have been under stress for a number of years due, among other things, to mortalities caused by the incidental drowning in shrimp trawls. An estimated 9,874 individuals are killed annually by shrimp trawlers in the Gulf of Mexico and southern North Atlantic (Henwood and Stuntz 1987).

Several sea turtle researchers (Ehrhart 1987; Frazer 1986; Murphy pers. comm.) have suggested that loggerhead turtle nesting populations in the U.S. are continuing to decline at rates of up to five percent annually. A theoretical explanation for these declines was recently published (Crouse et al. 1987). Applying a Leftovitch stage-class matrix model of loggerhead populations on Little Cumberland Island, GA, these authors showed that loggerhead population stability is more sensitive to changes in the subadult stage of development than in other developmental stages. Records of turtle mortalities from dredging indicate that the majority of those animals are subadults. By impacting the most sensitive developmental stages of loggerhead turtles, dredging may exert a major impact on the recovery of these stocks.

Green turtle (Chelonia mydas)

Green turtles are circumglobally distributed mainly in waters between the northern and southern 20°C isotherms (Hirth 1971). In the western Atlantic, several major nesting assemblages have been identified and studied (Peters 1954; Carr and Ogren 1960; Duellman 1961; Parsons 1962; Pritchard 1969a; Schulz 1975; Carr et al. 1978). In the continental U.S., however, the only known green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart 1979).

While nesting activity is obviously important in determining population distributions, the remaining portion of the green turtle's life is spent on the foraging grounds. Some of the principal feeding pastures in the western Atlantic Ocean include: upper west coast of Florida, northwestern coast of Yucatan peninsula, south coast of Cuba, Mosquito Coast of Nicaragua, Caribbean coast of Panama, scattered areas along Colombia, and scattered areas off the Brazilian coast (Hirth 1971). The preferred food sources in these areas are: Cymodocea, Thalassia, Zostera, Sagittaria and Vallisneria (Babcock 1937; Underwood 1951; Carr 1954; Carr 1952; Neill 1958; Mexico 1966).

Although no green turtle feeding pastures or major nesting beaches have been identified on the southeast Atlantic coast, evidence provided by Mendonca and Ehrhart (1982) indicates that immature green turtles may utilize lagoonal systems during periods of their lives. These authors identified a population of young green turtles (carapace length 29.5 - 75.4 cm) believed to be resident in the Mosquito Lagoon, Florida. The Indian River system, of which Mosquito Lagoon is a part, supported a green turtle fishery during the late 1800's (Ehrhart 1983), and these turtles may be remnants of this historical colony. Similar use of inshore systems may occur in North Carolina waters, as well.

Kemp's ridley turtle (Lepidochelys kempi)

Of the seven extant species of sea turtles of the world, the Kemp's ridley is probably in the greatest danger of extinction. The only major nesting area for this species is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; Hildebrand 1963). Virtually the entire world population of adult females nest annually in this single locality (Pritchard 1969b). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the early 1970's, the world population estimate of mature female Kemp's ridleys had been reduced to 2500-5000 individuals. Most recent estimates of the total population of sexually mature female Kemp's ridleys are 540 turtles (Byles pers comm 1985).

The foraging range of mature Kemp's ridley turtles is restricted to the Gulf of Mexico. Evidence provided by tagging programs (Chavez 1968), suggests that post-nesting females move in comparable numbers to the north (mostly to Louisiana) and to the south (mostly to Campeche) (Pritchard and Marquez 1973). It is assumed that adult male turtles follow similar migratory patterns.

Movements of hatchling Kemp's ridley turtles may be controlled by current patterns: either the loop current for northward transport or an eddy for southward transport with occasional transportation through the Florida Straits via the Gulf stream (Hildebrand 1982). Young Kemp's ridley turtles are known to occur in eastern U.S. coastal waters from Florida to Canadian portions of the Gulf of Maine (Lazell 1980). Pritchard and Marquez (1973) suggest that passive transportation via the Gulf Stream up the eastern coast of the U.S. may be the usual dispersal pattern of young Kemp's ridley turtles. They speculate that turtles feed and grow rapidly during passive transport, and by the time they reach offshore waters of New England they are large enough for active swimming. At this stage they reverse the direction of travel toward the Gulf of Mexico. Kemp's ridley turtles feed primarily in shallow coastal waters on bottom-living crustaceans (Hildebrand 1982). Organisms identified from stomachs include crabs (<u>Polyonchus</u>, <u>Hepatus</u>, <u>Callinectes</u>, <u>Panopeus</u>, <u>Mineppe</u>, <u>Ovalipes</u>, <u>Calappa</u>, <u>Portunus</u>, <u>Arenaeus</u>), fish (<u>Lutjanus</u>, <u>Leiostomus</u>) and molluscs (<u>Noculana</u>, <u>Corbula</u>, <u>Mulinia</u>, <u>Nassarius</u>) (Dobie et al. 1961; Pritchard and Marquez 1973). All of these genera are forms common in the Gulf of Mexico and the eastern coast of the United States.

Kemp's ridley turtles may also burrow in the bottom mud of channels during periods of extreme low temperature, as has been observed with loggerheads. Adverse effects may occur if ridleys are dislodged from the warmer mud during extreme cold periods. "Cold-stunning" is likely to occur if Kemp's ridleys are subjected to temperatures below $11^{o}C$ for extended periods; therefore, during winter dredging, ridleys may be in a torpid state and unable to react to the suction of the oncoming draghead.

Shortnose sturgeon (*Acipenser brevirostrum*)

Shortnose sturgeon occur in rivers, estuaries, and at sea, along the east cost of North America from the Saint John River, New Brunswick, Canada (Leim and Day 1959), to the Indian River, FL (Evermann and Bean 1898). This anadromous species migrates upriver to spawn (spawning occurs between February and May depending on latitude), and returns downstream in the fall (Dadswell et al. 1984). In some river systems during the fall, a portion of the breeding adults migrate upstream to deep, overwintering sites adjacent to the spawning grounds (Greeley 1935; Dadswell 1979; Dovel 1981; Buckley 1982); some ripening and most nonripening adults spend the winter in deep, saline sites (Dadswell 1979; Marchette and Smiley 1982). Juveniles and post-spawning adults may move downstream to areas adjacent to the salt wedge during the summer months (June through August). As water temperatures cool, adults move to the lower estuary where salinities exceed 15 ppt.

The shortnose sturgeon is a benthic feeder whose diet is composed of small invertebrates and occasional plant material. Juvenile sturgeon feed primarily on benthic insects and crustaceans, while adult sturgeon eat mostly molluscs (Dadswell 1984). The species composition of food items found in sturgeon stomachs varies according to the river system in which the animal was captured, and whether the sturgeon was taken in fresh or salt water. During the summer months, sturgeon forage at night in shallow areas over mud bottom in depths of 1-5 m; winter feeding is restricted to deeper waters with mud bottoms. In saline waters, sturgeon feed over sandy or mud bottoms in 5-10 m depths.

Assessment of Impacts

Dredging could negatively impact right whales through harassment, injury, and mortality while hopper dredges are in transit to and from the offshore disposal sites. The potential for right whale/vessel collisions would be highest during time periods when whales are migrating to and from the calving grounds off Georgia and northern Florida. NOAA Fisheries does not anticipate any effects of the proposed dredging activity on populations of right whales, but believes that additional precautions to avoid vessel/right whale collisions may be necessary during the months of December through April.

Of all the activities which may negatively impact sea turtles, the only quantitative information available concerns the catch and mortality of sea turtles by shrimp trawlers. However, we are beginning to develop a significant data base on sea turtle mortalities associated with channel dredging operations using a hopper dredge. During maintenance dredging of Cape Canaveral Harbor, Florida, entrance channel, well over 100 sea turtle mortalities have been documented. At Kings Bay, Georgia, a minimum of 11 sea turtles were killed during recent construction dredging. Sea turtles are known to occur in navigational channels all along the eastern seaboard, and it appears likely that hopper dredges will take sea turtles in any channels where turtles reside. The magnitude of potential impacts from these activities, considered on an additive basis for the southeast region is unknown, but could be significant. The proposed project may result in the injury or death of an unknown number of sea turtles, particularly in areas where hopper dredges are used.

Potential direct impacts to shortnose sturgeon, such as harassment, injury and mortality, may result from channel dredging. Although we have no direct evidence that sturgeon occur in the project area, the recent discovery of shortnose sturgeon in the Brunswick River, N.C., suggests that the Cape Fear River drainage probably contains a self-sustaining population of shortnose sturgeon. Assuming that sturgeon reside in the project area, the dredging of the channel could result in injury or death of an unknown number of individuals.

Conclusions

Right whale:

NOAA Fisheries concludes that the proposed activities are not likely to jeopardize the continued existence of the right whale (Balaena glacialis). However, we believe that additional precautions should be taken during December through April when right whales may be migrating along the coast. NOAA Fisheries concludes that hopper dredging and offshore disposal during these times may affect right whales, and that a right whale "watch" should be instituted aboard the dredges during these times to assure that dredge/whale collisions during transit to and from the offshore disposal site are avoided.

Sea Turtles:

NOAA Fisheries concludes that dredging with a hopper dredge may affect the green turtle (Chelonia mydas), the Kemp's ridley turtle (Lepidochelys kempi), and the loggerhead turtle (Caretta caretta). This conclusion is based on the critically small population sizes of Kemp's ridley and green turtles, the suspected occurrence of greens and Kemp's ridleys in the shipping channel, the known adverse impacts on sea turtles associated with hopper dredging, and the cumulative impacts of past and future dredging on these species. The additive effects of hopper dredging may negatively impact the loggerhead turtle (Caretta caretta), because of the annual magnitude of hopper dredging in the southeastern U.S., and the fact that subadult loggerheads are the predominant turtles taken during these activities.

Shortnose sturgeon:

Based on the best available information, NOAA Fisheries believes that the proposed activity is not likely to jeopardize the continued existence of populations of the shortnose sturgeon. However, we conclude that channel dredging may adversely affect shortnose sturgeon by displacement, injury or mortality of an undetermined number of fishes within the population. A conservation recommendation and an incidental take statement containing measures to reduce these adverse impacts are provided with this opinion.

Critical habitat

No critical habitat for sea turtles or the shortnose sturgeon has been designated or proposed within or near the project site.

Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation. At this time, there are no known projects or activities of this type ongoing or planned within the project site.

Reinitiation of Consultation

Reinitiation of consultation is required if (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of this action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

Conservation Recommendation

Pursuant to Section 7(a)(1) of the ESA, the following conservation recommendations are made to assist the Corps of Engineers in reducing or eliminating adverse impacts to sea turtles and shortnose sturgeon resulting from dredging in the vicinity of Wilmington Harbor - Northeast Cape Fear River, New Hanover and Brunswick Counties, North Carolina.

1. A survey to establish the distribution and abundance of shortnose sturgeon in the Cape Fear drainage should be conducted. This survey should provide basic biological information on the shortnose sturgeon including movements, seasonality, size and age structure, migration patterns, feeding habits, etc. This study should be designed to provide needed information on the shortnose sturgeon for this project, and future maintenance dredging and improvements of channels in the area.

Incidental Take Statement

Section 7(b)(4) of the Endangered Species Act requires that when a proposed agency action is found to be consistent with Section 7(a)(2) of the Act and the proposed action may incidentally take individuals of listed species, NOAA Fisheries will issue a statement that specifies the impact (amount or extent) of such incidental taking and the terms and conditions that must be followed. Only incidental taking by the Federal agency or applicant that complies with the specified terms and conditions of this statement, is authorized and exempt from the taking prohibition of the ESA.

No records of sea turtle or shortnose sturgeon take in the project area have been reported. However, there is a growing body of evidence that dredging with a hopper dredge may adversely affect turtles; it is also possible that shortnose sturgeon may experience negative impacts as a result of dredging activities. Therefore, pursuant to Section 7(b)(4) of the ESA, an incidental take (by injury or mortality) level of one documented Kemp's ridley or green turtle, ten loggerhead turtles or ten shortnose sturgeon is set for this project. If the incidental take meets or exceeds this specified level, the COE must reinitiate consultation. The Southeast Region, NOAA Fisheries, will cooperate with the COE in the review of the incident to determine the need for developing further mitigation measures.

The reasonable and prudent measures that NOAA Fisheries believes are necessary to minimize the impact of incidental takings associated with the proposed project have been discussed with the COE and will be incorporated in the project design. The following terms and conditions are established for this project to implement the identified mitigation measures and to document the incidental take should such take occur:

1) A preliminary gill net survey of the project site will be conducted to determine the presence of shortnose sturgeon. This survey will be completed prior to dredging.

2) If the preliminary survey indicates large concentrations of sturgeon or if sturgeon mortalities are observed during dredging, the COE should be prepared to implement a plan to capture and remove shortnose sturgeon from the immediate vicinity of the project.

3) The contractor will advise workers that there are civil and criminal penalties for harming, harassing or killing sea turtles, or shortnose sturgeon which are protected under the Endangered Species Act of 1973, as amended. The contractor will keep a log detailing all sightings, collisions, damage or killing of sea turtles

or shortnose sturgeon, and shall be held responsible for any listed species harmed, harassed or killed as a result of dredging.

4) Any take of sea turtles or shortnose sturgeon resulting in injury or death to the animal will be reported immediately to the Wilmington District COE and to NOAA Fisheries Southeast Regional Office.

5) If hopper dredges are used, vessels should be adequately screened to document turtle or shortnose sturgeon mortalities, and a minimum 25% observer coverage should be maintained.

Section 7(b)(4)(C) of the ESA specifies that in order to allow an incidental take of an endangered or threatened marine mammal species, the taking must be authorized under Section 101 (a)(5) of the Marine Mammal Protection Act of 1972. Since no taking of marine mammals incidental to the proposed activity has been requested or authorized, no statement on incidental take of endangered or threatened marine mammals is provided.

REFERENCES

Anonymous. 1985. Offshore Georgia: Calving ground for an Endangered Species. Coastlines, Vol. 8, No. 1, pp 8-11.

Babcock, H. L. 1937. The sea turtles of the Bermuda Islands, with a survey of the present state of the turtle fishing industry. Proc. Zool. Soc. Lond. 107: 595-601.

Buckley, J. L. 1982. Seasonal movement, reproduction, and artificial spawning of shortnose sturgeon (Acipenser brevirostrum) from the Connecticut River. M.S. Thesis, University of Massachusetts, Amherst. 64pp.

Butler, R. W., W. A. Nelson and T. A. Henwood. 1987. A Trawl survey method for estimating loggerhead turtle, Caretta caretta, abundance in five eastern Florida channels and inlets. Fishery Bulletin, Vol. 85, No. 3.

Byles, R. Personal Communication. U.S. Fish and Wildlife Service.

Carr, A. F. 1952. Handbook of turtles. Ithaca, New York: Cornell University Press.

Carr, A. F. 1954. The passing of the fleet. A.I.B.S. Bull., 4(5): 17-19.

Carr, A. F. 1963. Panspecific reproductive convergence in Lepidochelys kempi. Ergebn. Biol. 26: 298-303.

Carr, A. F., M. H. Carr and A. B. Meylan. 1978. The ecology and migrations of sea turtles. 7. The western Caribbean green turtle colony. Bull. Amer. Mus. Nat. Hist. 162(1): 1-46.

Carr, A. F. and L. Ogren. 1960. The ecology and migrations of sea turtles 4. The green turtle in the Caribbean Sea. Bull. Amer. Mus. Nat. Hist. 131(1): 1-48.

Carr, A., L. Ogren and C. McVea. 1980. Apparent hibernation by the Atlantic loggerhead turtle of Cape Canaveral, Florida. Biol. Conserv. 19: 7-14.

Carr, D. and P. H. Carr. 1978. Survey and reconnaissance of nesting shores and coastal habitats of marine turtles in Florida, Puerto Rico and the U.S. Virgin Islands. NMFS report. 34pp.

Chavez, H. 1968. Marcado y recaptura de individuos de tortuga lora Lepidochelys kempi (Garman), Inst. Nac. Inv. Biol. Pes., Mexico, Vol 19, 28pp.

Crouse, D. T., L. B. Crowder and H. Caswell. 1987. A stage-based model for loggerhead sea turtles and implications for conservation. Ecology 68(5): 1412-1423.

Dadswell, M. J. 1979. Biology of the shortnose sturgeon (Acipenser brevirostrum) in the Saint John River estuary, New Brunswick, Canada. Trans. Atl. Chap. Can. Soc. Environ. Biol. Annu. Meet. 1975: 20-72.

Dadswell, M. J., B. D. Taubert, T. S. Squires, D. Marchette and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, Acipenser brevirostrum LeSueur 1818. FAO Fisheries Synopsis No. 140. NOAA Tech Report NMFS 14, U.S. Dept. of Commerce, 3300 Whitehaven St., Washington, DC.

Dobie, J. L., L. H. Ogren and J. F. Fitzpatrick, Jr. 1961. Food notes and records of the Atlantic ridley turtle (Lepidochelys kempi) from Louisiana. Copeia 1961(1): 109-110.

Dovel, W. L. 1981. The endangered shortnose sturgeon of the Hudson estuary: Its life history and vulnerability to the activities of man. An investigation by the Oceanic Society under contract (No. DE-AC-39-79-RC-10074) to the Federal Energy Regulatory Commission, Washington, D.C. 139pp.

Duellman, W. E. 1961. The amphibians and reptiles of Michoacan, Mexico. Publ. Univ. Kans. Mus. Nat. Hist., 15: 1-148.

Ehrhart, L. M. 1979. A survey of marine turtle nesting at Kennedy Space Center, Cape Canaveral Air Force Station, North Brevard County, Florida, 1-122. Unpublished report to Division of Marine Resources, St. Petersburg, Florida, Fla. Dept. Nat. Res.

Ehrhart, L. M. 1983. Marine turtles of the Indian River lagoon system. Florida Sci. 46(3/4): 337-346.

Ehrhart, L. M. 1987. A status review of the loggerhead turtle, Caretta caretta, in the Western Atlantic. WATS Proceedings (Unpublished).

Ernst, L. H. and R. W. Barbour. 1972. Turtles of the United States. Univ. Kentucky Press, Lexington Ky.

Frazer, N. B. 1986. Survival from egg to adulthood in a declining population of loggerhead turtles, Caretta caretta. Herpetologica 42:47-55.

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collum, W. Hoffman and M. A. McGehee. 1983. Turtles, birds and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U.S. Fish and Wildlife Serv. Div. Biol. Ser., Washington, D.C.

Greeley, J. R. 1935. Fishes of the watershed with annotated list. In A biological survey of the Mohawk-Hudson Watershed. Rep. N.Y. State Conserv. Dep., Suppl. 24: 63-101.

Henwood, T. A. 1987. Movements and seasonal changes in loggerhead turtle, Caretta caretta, aggregations in the vicinity of Cape Canaveral, Florida (1978-84). Biol. Conserv. Vol. 40, No. 3: 191-202.

Henwood, T. A. and L. H. Ogren. 1987. Distribution and migrations of immature Kemp's ridley turtles (Lepidochelys kempi) and green turtles (Chelonia mydas) off Florida, Georgia and South Carolina. Northeast Gulf Science Vol. 9, No. 2: 153-159.

Henwood, T. A. and W. E. Stuntz. 1987. Analysis of sea turtles captures and mortalities during commercial shrimp trawling. Fishery Bulletin Vol. 85, No. 4: 813-817.

Henwood, T. A. 1987. Cruise Report: October 15, 1987, COE Survey of turtle populations in the Cape Canaveral ship channel shoreward of the jetties. (Unpublished).

Hildebrand, H. H. 1963. Hallazgo del area de anidacion de la tortuga marina "lora", Lepidochelys kempi (Garman), en la costa occidental del Gulfo de Mexico. Ciencia, Mex 22(4): 105-112.

Hildebrand, H. H. 1982. A historical review of the status of sea turtle populations in the western Gulf of Mexico. pp 447-453 In: Biology and conservation of sea turtles. K. A. Bjorndal. (ed.) Smithsonian Institution Press, Washington, D.C.

Hirth, H. F. 1971. Synopsis of biological data on the green turtle Chelonia mydas(Linnaeus) 1758, FAO Fisheries Synopsis No. 85: 1-77.

Kraus, S. Personal Communication. New England Aquarium. Boston, MA.

Lazell, J. D. 1980. New England waters: critical habitat for marine turtles. Copeia 1980(2): 290-295.

Leim, A. H. and L. R. Day. 1959. Records of uncommon and unusual fishes from Eastern Canadian waters, 1950-1958. J. Fish. Res. Board Can. 16: 503-514.

Marchette, D. E. and R. Smiley. 1982. Biology and life history of incidentally captured shortnose sturgeon, Acipenser brevirostrum, in South Carolina. S.C. Wildl. Mar. Res. unpubl. ms 57pp.

Mendonca, M. T. and L. M. Ehrhart. 1982. Activity, population size and structure of immature Chelonia mydas and Caretta caretta in Mosquito Lagoon, Florida. Copeia (1982)1: 161-167.

Mexico. 1966. Instituto Nacional de Investigaciones Biologico-Pesqueras. Programa nacional de marcado de tortugas marinas. Mexico, INIBP: 1-39.

Mortimer, J. 1982. Feeding ecology of sea turtles. pp 103-109 In: Biology and conservation of sea turtles. K. A. Bjorndal (ed.) Smithsonian Institution Press, Washington, D.C.

Murphy, S. A. Personal Communication. South Carolina Wildlife and Marine Resources Department.

Neill, W. T. 1958. The occurrence of amphibians and reptiles in salt water areas, and a bibliography. Bull. Mar. Sci. Gulf Caribb. 8: 1-97.

Parsons, J. J. 1962. The green turtle and man. Gainesville, University of Florida Press.

Peters, J. A. 1954. The amphibians and reptiles of the coast and coastal sierra of Michoacan, Mexico. Occ. Pap. Mus. Zool. 554: 1-37.

Pritchard, P. C. H. 1969a. Sea turtles of the Guianas. Bull. Fla. State Mus. 13(2): 1-139.

Pritchard, P. C. H. 1969b. The survival status of ridley sea turtles in American waters. Biol. Cons. 2(1): 13-17.

Pritchard, P. C. H. and R. Marquez. 1973. Kemp's ridley turtle or Atlantic ridley. I.U.C.N. Monograph No. 2, Morges, Switzerland.

Rebel, T. P. 1974. Sea turtles and the turtle industry of the West Indies, Florida and the Gulf of Mexico. Univ. Miami Press, Coral Gables, Florida.

Ross, J. P. 1982. Historical decline of loggerhead, ridley and leatherback sea turtles. pp 185-195 In: Biology and conservation of sea turtles K. A. Bjorndal (ed.) Smithsonian Institution Press, Washington, D.C.

Schult, J. P. 1975. Sea turtles nesting in Surinam. Sool. Verh. 143: 1-143.

Shoop, C., T. Doty and N. Bray. 1981. Sea turtles in the region between Cape Hatteras and Nova Scotia in 1979. pp IX 1-85 In: A characterization of marine mammals and turtles in the mid- and north-Atlantic areas of the U.S. outer continental shelf: Annual report for 1979. Univ. Rhode Island, Kingston.

Underwood, G. 1951. Introduction to the study of Jamaican reptiles. Part 5. Nat. Hist. Notes Nat. Hist. Soc. Jamaica 46: 209-213.

UNITED STATES D ARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9450 Koger Boulevard
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JAN 13 1989

F/SER23:TAH:td

Colonel Paul W. Woodbury
U.S. Army Corps of Engineers
Wilmington District
P.O. Box 1890
Wilmington, N.C. 28402-1890

Dear Colonel Woodbury:

This responds to questions raised by your staff regarding the December 23, 1988, Biological Opinion (BO) on long-term maintenance dredging of the Wilmington Harbor Project. Concern was expressed over the incidental take statement and the requirement for gill net surveys of the project site prior to dredging. I would like to clarify our position on these surveys.

The National Marine Fisheries Service (NOAA Fisheries) intent in requiring these surveys was to assure that adequate precautions are taken to protect endangered shortnose sturgeon populations in the Cape Fear drainage. Surveys were identified in our BO as a conservation recommendation; however, the U.S. Army Corps of Engineers (COE) are not obligated to implement this recommendation. If the recommended surveys are not conducted, NOAA Fisheries believes that individual project sites should be sampled for shortnose sturgeon prior to dredging. This reasonable and prudent measure is a precaution to assure that unexpected numbers of shortnose sturgeon are not impacted by any dredging event. If the COE implement our conservation recommendation, site specific surveys will not be necessary because the research surveys will provide the needed information on sturgeon distributions and movements.

Finally, the site specific surveys will not be necessary during every dredging cycle. When sufficient data are available to establish that sturgeon are not likely to be impacted by dredging in a given area, there is no need to continue pre-dredging sampling. Also, if the timing of the dredging is such that sturgeon are not likely to occur in the area, there is no reason to conduct pre-dredging surveys.

NOAA Fisheries believes that long-term maintenance dredging of the Wilmington Harbor Project will not jeopardize populations of shortnose sturgeon if reasonable precautions are exercised. We also believe that timing of the dredging can be adjusted to assure that the least number of individuals will be impacted during any dredging event. To avoid a potential dredging/endangered species conflict, basic research is needed to determine when, and if, shortnose sturgeon may be present in areas scheduled for dredging.

If you have additional questions regarding the BO or the incidental take statement, please contact Dr. Terry Henwood at FTS 826-3366.

Sincerely yours,

Joseph W. Angelovic, Ph.D.
Acting Regional Director

cc: F/PR2

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Regional Office

January 13, 1989

<u>Response</u>:

1. Section 5.3 of the final EIS addresses these comments.